

Piggery India

Year Book 2000



Dr. Chandra Shekhar Sahukar

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PREFACE

This book is the comprehensive manual of skills, techniques, technical knowhow and the most versatile tool available to the Indian Pig Industry. It captures a spectacular range of images from infrastructure to the advanced technology of pig production and pork processing and aimed both at the beginner and the experienced farmer or professional engaged in this field. It is the first compendium of its kind specifically planned for Pig farmers, Veterinarians, Bank Officials, Pork Processors, Scientists, Government Officers engaged in this field.

It is also a handy tool for the foreign pig breeding companies, equipment manufacturers, feed and medicines and vaccine suppliers who are interested to extend their business in India. It encompasses all the major aspects of the subject, from the fundamental needs to advanced technology and methods of approaching the modern pig industry. The technical knowledge of this industry has been carefully conceived to help the farmers for achieving almost every possible desired effect for maximum profit. It outlines all the important aspects of pig enterprise and would be helpful in developing a personal style for planning a project.

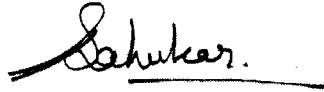
To foster a better understanding of the subject, it is divided into 50 chapters, which enlightens all the important and dynamic aspects of pig production. I have tried to show most techniques and a variety of styles in common use relating to Organization and infrastructure, Housing and Management, Nutrition and Feeding, Breeding and Selection, Reproduction and Artificial Insemination, Health and Disease, Financing and Insurance Coverage, Pork Processing Industries and Human Resources Development.

It also contains a special chapter on "Wild Boar", an ancestor of domestic pigs, which includes wild boar in history, art and culture, types of wild boars of the World, behavior, feeding, breeding and management in zoos and National parks

and efforts for conservation in India.

The book ends with an alphabetically arranged Directory of reference list of addresses for Pig Production, Pig Breeding Farms of India, Addresses of Zoos with Wild boars, National Parks of India, Zoo Development Authority, Bacon Factories, Veterinary Colleges, Agricultural Universities, Directorate of Marketing & Inspection, APEDA etc.

This book is a practical approach to Indian Pig Industry. I hope that, it will serve not only as an invaluable work of reference for every pig industrialist, but also a source of inspiration for the development of Indian Pig Industry.



DELHI

15th August, 2000

(Chandra Shekhar Sahukar)

1. INTRODUCTION

Pigs produce high quality protein to supplement large quantities of economically produced food in the human diet. In many parts of the world they also provide by-products, manure for fertilizer and bio-gas, and serve as a means of capital generation, insurance against risk and a mode of exchange. They also serve as international buffer for stabilizing grain prices and supplies. The pork products are becoming increasingly important for most people of the earth in meeting world food requirements.

In the pig production there are five major frontiers for future scientific exploration. These are genetic improvement, improved feeding, disease control, management and system of raising. Reproductive efficiency of pigs have been greatly improved. Sows will remain valuable, not only for producing more number of piglets but also for dispensing colostrum and producing milk for 3 weeks lactation.

Following factors plays an important role in profitable pig production; breeding at earlier age, i.e. 6-7 months, farrowing at 10 months of age, litter size of 10-12 pigs farrowed/litter, weaning 9-10 pigs/litter after 3 weeks lactation and re-breeding 5-7 days post weaning will allow up to 2.5 litters/sow/year and up to 25 pigs marketed/sow/year.

A significant effort for pigs is essential towards the development of new genetic types that will respond to harsher environments, economic constraints and restricted feed supplies. In India, the costs are too high to modify the environment.

In developing countries, resources are not sufficient to show the productivity of genetically superior pigs. A means of overcoming genetic vulnerability with pigs is to work indigenous breeds and through genetic manipulation within the native breeds.

The synthetic lysine and tryptophane plays an important role in reducing the amount of soybean meal used. The practical production of bacterial and yeast protein will allow use of low grade Feedstuff for the pigs.

Disease control is very important for maximizing profits in pig production. The reduction of deaths between conception and weaning have great potential for improving of biological productivity of pigs. Recombinant DNA technology offer remarkable opportunities for re-structuring animal phenotypes, producing disease protective vaccines, and for efficient production of hormones, vitamins and anti-bacterial agents for the most efficient pig production. Computers plays an important role in increasing the production efficiency at Government Pig Breeding Farms, for disease control, day to day management, feeding and strategic planning.

Animal rights and welfare are receiving considerable attention by the press and in legal, philosophical, political and animal welfare organizations with a theme to reduce stress during production practices. Modern production methods have greatly enhanced the welfare of pigs. Humane care is essential for economic gains for producers and consumers of pork. Pigs are produced to enhance human welfare and a rational consideration of animal welfare requires that it be placed in perspective relative to human welfare.

The integrated farming system is important in India. A typical example is found in Taiwan in a combination of fish and swine. The waste generated from 250 pigs is sufficient to produce 6 metric tons of fish/hectare/year. The waste generated from pig farm provide a very cost efficient means of fish production and at the same time utilizes paddy land which helps relieve the overproduction of rice.

1.1 Piggery Development in India

The increase pressure of Indian population and the need to raise living standard has created the scope for the production of more animal products and its effective preservation. The meat production from buffalo, sheep and goats is unlikely to keep pace with the population increase because of low prolificacy and a high generation interval. The expected increased meat consumption has thus to be met mainly by increased pig and pork production. Eggs and pig meat are the important sources



Fig1.1.1 A sow with her piglets.

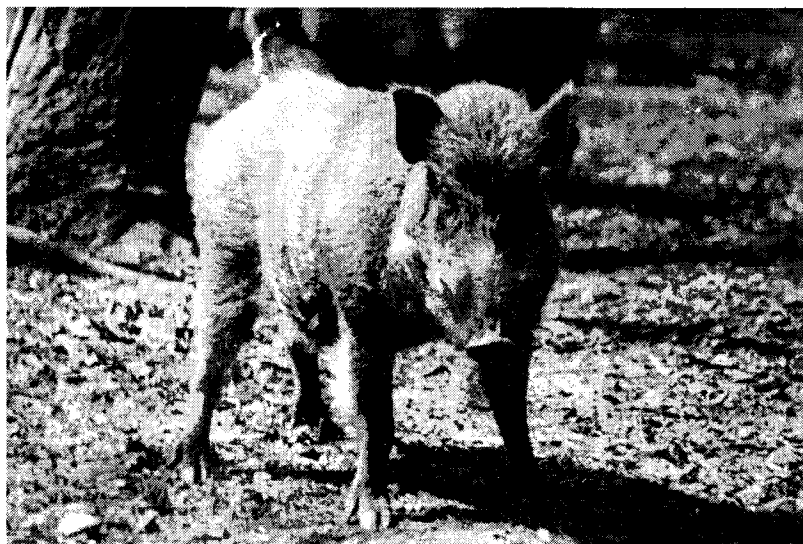


Fig. 1.1.2 Indian Wild Boar

of nutrients in the human diet because of their better nutritional make-up and utilization. Pig meat is an important source of animal proteins, vitamins, minerals and other nutrients. Indian pig industry can play an important role in the supply of high quality nutritious diet. Pig production is essential for the future development of Indian meat industry. Pig is one of the efficient food converter among domesticated livestock.

1.2 Deplorable Image of Pig

Pigs have an important economic importance to mankind yet suffer from such a deplorable image. It is a source of a wide variety of meats, high quality durable bristles and hundreds of medicinal products. The pig is frequently regarded as unclean and even untouchable by many people.

1.3 Pigs are the most intelligent domestic animal

In spite of their reputation, pigs are neither stupid nor filthy. Pigs seek relief from heat by wallowing in mud or shallow waterholes, due to ineffective sweat glands in lowering body temperature. Pigs have proved to be among the intelligent of all domestic animals, even more intelligent than dogs.

1.3.1 Pigs can do independent thinking

Some scientists say that, unlike dogs and horses, pigs do independent thinking and can figure out a problem for themselves- the dictionary definition of intelligence.

1.3.2 Pigs can be easily trained

Pigs with proper training, quickly learn how to dance, tumble, retrieve, and dive; how to fetch newspapers or pull a cart. Hogs can even be trained to sniff out land mines in combat zones. Rewards- affection and food are the training tools.

1.3.3 Pigs will not overeat

Unlike horse, dog and man, pigs will not dangerously overeat, even with unlimited food available to them. A pig does not bolt its food, but chews it, and savors it, and shoves it about with the snout to release the aroma.

1.3.4 Pigs would reject the worst food

In one classic experiment 243 kinds of vegetables were offered to a pig, the animal refused 171. Where it finds variety,

it will reject the worst with as distinguished a taste as other quadrupeds. Their taste for the best is equally distinguished.

1.3.5 The Black Diamonds of gastronomy

In the Perigord region of France, where the world's best black truffles grow, farmers have traditionally used female pigs as *chercheuses*-searches-for the \$200-a-pound fungi. Truffles grow from 2 to 12" below ground, and it is the pig's job to sniff off this buried treasure. It can detect a truffle 10 inches deep from a distance of 20 feet. Dogs can also perform the same task, but they can detect the ripest of the fungi and are required to be worked daily, while the pig's supersensitive snout, once a week is enough.

1.4 Why Raise Pigs?

Pig rearing fits in very well with mixed farming and can also be complementary to intensive crop production operations. In India, pig farming has a special significance and can play an important role in improving the socioeconomic status of a sizable section of the weaker community. Pig rearing is very popular amongst tribal population. Government has extended a great help to the weaker sections of the society by arranging subsidy and loans for pig farming through various schemes.

Women can play a significantly role in the rural pig production for their socio-economic uplift. In many societies at village level, the management and care of animals is predominantly woman's work and their social responsibility. Even where the management and care of animals is predominantly men's work, women may be responsible for important subsidiary tasks such as feeding and watering, cleaning and looking after sick animals. Women handle delicate piglets with care and get easily involved in the jobs assigned to them. Pig provides pin money to the house wife and helps her to look after the family's nutritional needs. Pig rearing offers opportunities for women's employment. However, the pig units owned by women is not a story of success, all the way. The factors responsible for the failure of pig units include: the lack of assured supply of feed, or prompt and adequate veterinary

services and of proper and technical support. High mortality in the herd is often due to delay in the availability of veterinary services. Lack of adequate funds results in the construction of badly designed pig house. These constraints should be given due consideration by Government planners and other concerned with extension work in rural areas.

In recent years, with the introduction of purebred exotic stock and improved methods of breeding, feeding, management and meat handling, this industry is expected to play a significant role in the economy of the country. Pig farming needs low investment, simple skills and little land. It can also be practiced as a cottage industry. The production potential of indigenous breeds is very low. In recent years, pig breeds have been selected to produce more number of piglets and good quality of pig meat. Genetic improvement of indigenous breeds, adapted exotic breeds and their crosses have been carried out by a network of State Government Pig Breeding Farms established all over the country to supply high producing exotic and cross-bred piglets. These farms receive their grand parent/parent stocks from the internationally reputed breeders.

Feed accounts about 80 percent of the total cost of pig production. Efficient use of cheaper rations based on locally available materials and agricultural by-products are essential for profitable pig production. Modern technology of pig feeding consists of meeting the biological needs with proper combination of feed ingredients and locally available by-products to yield the economical piglets and pig meat. The rapid expansion of pig farming has resulted in the development of high technology and its introduction into the production process to the farmers. The technical know-how based on scientific research is essential for the development of Indian pig industry. Training imparts skills in farmers and persons engaged in pig production and extension work. Disease is an important cause of loss in pig production. Piglets are susceptible to a number of diseases which affect their appetite, growth, feed conversion efficiency and pork production. An efficient husbandry system should act as barrier

to the introduction of diseases from outside and a systematic method of controlling the diseases within. In commercial pig production the control of important pig diseases is possible through vaccination and antibiotic feeding.

The Government of India and banks provides favorable climate for the farmers without directly involving themselves in the economic process. The nationalized banks through a large branches network provides financial assistance at a concessional rate. In order to provide effective thrust for the development of pig industry, a master policy has been introduced in consultation with banks for automatic insurance coverage of all financed stocks right from the period of purchase. India has an excellent possibilities for a flourishing pig industry. Stimulation of this industry can to a great help to; solve the problem of poverty and malnutrition, utilization of agricultural by-products, diversify agricultural production and employ available manpower resources.

1.5 Advantages of Pig Raising

Pig rearing fits in very well with mixed farming and can also be complementary to intensive crop production operations. In India, pig farming has a special significance and can play an important role in improving the socioeconomic status of a sizable section of the weaker community. Pig rearing is very popular amongst tribal population particularly in the North Eastern parts of the country. Government has extended a great help to the weaker sections of the society by arranging subsidy and loans for pig raising through various schemes. Some of the important schemes are Special Livestock Breeding Programme (SLBP), Intensive Rural Development (IRD) and Prime Minister's Rojgar Yojana (PMRY).

The great majority of pigs are raised for the purpose of producing pork. However, a small number are maintained primarily as a source of improved breeding stock. The sale of pigs which are to be used for breeding purpose has traditionally been restricted to purebred herds at Government Pig Breeding farms. The competition demands that breeder should develop

intelligent programs that will keep their herds highly productive for commercially important characters including high carcass quality. The breeding of herd requires special skill not possessed by every one. The sale outlet may even be the determining factor in the success of the breeding farm.

The raising of pigs can be practiced as a major enterprise and regularly serves as a principal source of income. The greatest success in pig farming comes only with the experience. It is well to begin with small numbers and increase the size of the unit gradually as the adaptability of the farm and one's own ability as an farmer are revealed by profits from the enterprise. As a minor enterprise pig production can be made to supplement several different enterprises. It may consist of several brood sows which maintained to produce the desired number of pigs or the required number of pigs may be purchased as feeders.

The large commercial farmer has some advantages, he can carry a greater number of breeding stock and can buy his requirements in large quantities at lower price. He can also achieve economics of scale in the use of labour and other inputs. A small farmer has advantages of his own. He can probably build the house cheaply with his own labour. The members of his family can help in the work in free hours. The waste and by-products from the house and farm, from neighbors and local hostel and kitchen waste can form an important part of the feed requirements. The cost of production of small farmer is lower and can earn a good profit.

The profits in pig farming is the difference between the cost of production and the net sale receipts of the live pigs or pork. It can be increased by reducing the cost of production. The main advantages of pig farming are as follows:

1. The pig is an efficient converter of feed into pork and pork products which have a high nutritional value in the human diet. They produce more live weight gain than other class of livestock.
2. Pigs are prolific breeder, grow rapidly, mature quickly and can be managed to produce more than two litters in a year.



Fig 1.5.1 Highly Prolific Sow

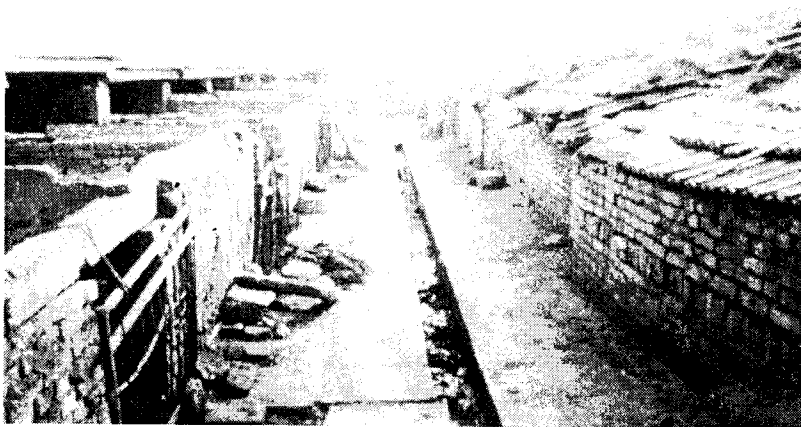
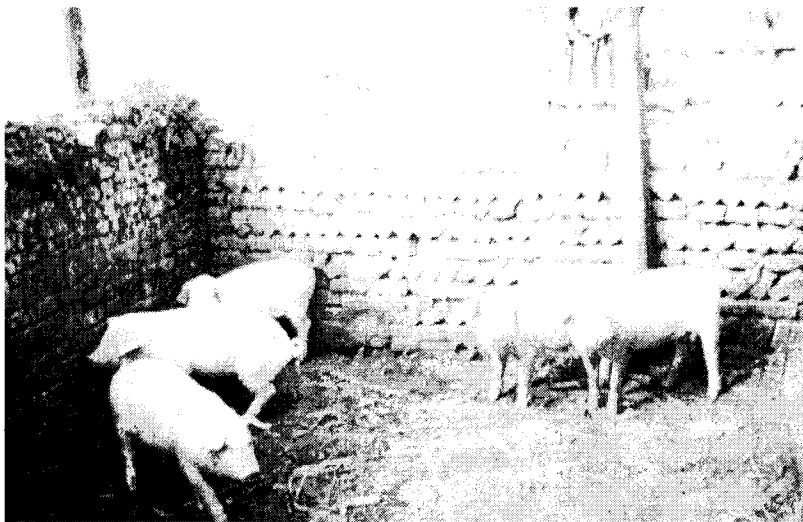


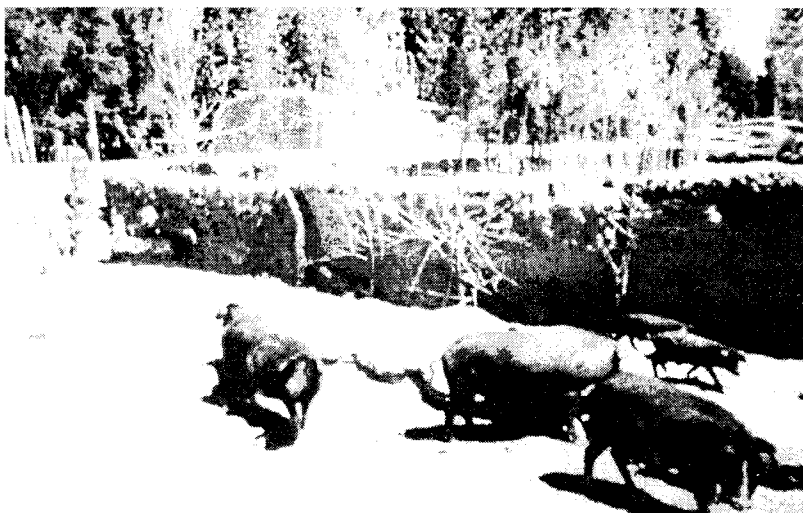
Fig.1.5.2 Private Pig Farm near Beijing (FAO Photo/C. Calpe).

3. Gilts can be bred at the age of 8-9 months.
4. Pigs can attain a live body weight of 90 kg. in 6-8 months.
5. Large acreages of land in our country are unutilizable, which can be utilized for raising of pigs.
6. The pig enterprise is flexible and farmer can increase the size of his farm as promise of increased profit appears.
7. The pig farming requires moderate investment than other farming.
8. Pig farming creates the profitable work for the available labour on the farm, as it can be successfully combined with dairy or other agricultural activity.
9. Pigs utilize the waste products very efficiently. Table garbage, bakery waste, hotel and kitchen waste and unmarketable fruits and vegetables can be fed to pigs.
10. Pigs may increase the efficiency of other enterprises like dairy farming by utilization of surplus labour.
11. Pigs aid in maintaining soil fertility. They produce the feces which can be converted into good biological manure.
12. The pig production has a special significance in the north-eastern regions, where every family rears pigs and they use pork as staple food.

The pig industry contributes to the Nation's economy to a great extent as the pork and pork products form 8 % of the total meat production. In recent years, with the introduction of purebred stock and improved method of breeding, feeding, management and health cover. This industry is expected to play a significant role in the economy of the country. The production potential of indigenous breed is very low. In recent times, pig breeds have been selected to produce lean meat. Genetic improvement of indigenous breeds, adapted exotic breeds and their crosses have been carried by the All India Co-ordinated Research Project on Pigs. Indian Veterinary Research Institute, Izatnagar has developed a black breed which is an efficient feed converter with economic ration. The rapid expansion of the pig farming has resulted in the development of high technology and its introduction into the production process to the farmers. The



*Fig.1.5.3 Medium Scale Pig Farm near Beijing
(FAO Photo/ C. Calpe).*



*Fig. 1.5.4 A Pig House of China
(FAO Photo/ J. Y. Piel).*



*Fig. 1.5.5 Pig raised by Private Farm of China
(FAO Photo/ C. Calpe).*



Fig. 1.5.6 Pigs-a source of income for an aged couple of Orissa

technical know-how is based on scientific research. The scientific research is performed at a number of institutions, pig breeding farms and All India Co-ordinated Research Project on Pigs. Training imparts skills in farmers and persons engaged in pig production and processing.

1.6 Pig-Human Organ Transplant

Pigs have been used for many years to provide heart valves for transplants. Pigs' physiological similarities to man- surpassed only by the primates- make the pigs invaluable to medical science. Primates cannot be used for organ transplant because of Wildlife Protection Act. Pigs organs are about the same size as human organs and very similar in shape and structure. Pigs grow rapidly and being reared as farm animals throughout the world. Pigs are being genetically engineered with added human genes to prevent their organs from being rejected by the human immune system. Tests have already shown that pig tissue with the added genes is protected against the first and most violent form of rejection. More than 40 transgenic pigs carrying a human genes which protects against complement have already been produced.

Dr. David White, leader of research team at Imutran, a Cambridge based company developing the transgenic pigs, says that, when they began work on the project in mid-1980s, it was seen as science fiction and widely unrealistic, but now following successes at the research level, at least three other groups, two in the United States and one in Japan, are also working to develop pigs as organs donors.

1.6.1 What organs can be donated by a pig?

A pig can donate hundreds of glandular and chemical derivatives that extend human life and alleviate pain.

Pig Skin

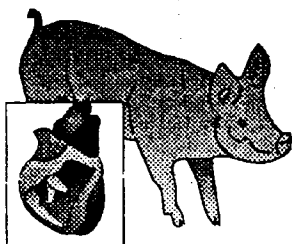
Pig skin itself finds a use at clinics such as the Parkland Memorial Hospital Burn Center in Dallas, Texas. The protective covering relieves the awful agony of burn-exposed flesh and because it clings without adhesive, can be easily peeled off.

THE HINDUSTAN TIMES, NEW DELHI, WEDNESDAY
AUGUST 17 1994

Have a (Pig's) Heart

TWO years ago, researchers in British injected a human DNA into the embryo of a pig. As a result, the piglet that was born six months later — it was named Astrid — carried a heart that would in some ways be compatible with the human immune system. In subsequent experiments, the researchers are trying to determine what would happen when human blood was pumped through hearts taken from the progeny of first transgenic pig. Astrid's progeny itself has since swelled to about 200 pigs in the past year and a half.

"It is absolutely clear," the researchers have concluded, "that



**“Hearts from
transgenic pigs
work better than
those from
normal pigs.”**

hearts from transgenic pigs work better than those from normal pigs and show fewer signs of immune rejection." What they, however, are not so sure of is whether that will translate into better survival rates when a "human heart" is transplanted from a pig to a primate.

The first trials of planting a pig's heart in a human body are expected to be undertaken in 1996. If these succeed, they could trigger off a multi-million dollar industry. But while the British company Imutran, which is sponsoring the project, is on the job, it has to race against a couple of American companies, who, too, are engaged in the business of producing "designer" hearts for human transplantation. One of them, the Boston-based DNX Corporation, has also been researching on mouse hearts in order to determine how compatible these would be with the human immune system. Alexion, another US company in the race, is hoping to transplant the designer pig hearts on primates by the end of year. "If we can get decent survival, we'll move on to humans."

"Everything is beginning to hot up," says the British Imutran, "but we like to think we're still in the lead." Whoever wins in this race will have to contend with the ethical issue relating to using pigs as factory for producing human hearts.

If these experiments succeed, they may provide the answer to the acute shortage of human organs for transplantation. Though experiments are on simultaneously to examine the possibility of transplanting some other organs genetically developed on animal bodies on to the humans, still, the heart, as the phrase goes, is at the heart of the problem. For while a kidney patient can be kept waiting for months until a suitable human donor is found and matched,

THE HINDUSTAN TIMES, NEW DELHI, TUESDAY
AUGUST 15 1995

Pig-to-human transplant soon

NEW DELHI, Aug. 14 (PTI)

Pig-to-human transplants within two to three years may solve the problem of a shortage of human donor organs with kidneys and hearts and possibly other organs from pigs being used in human patients.

Pigs are chosen because their organs are about the same size as human organs and very similar in shape and structure. They grow rapidly to adulthood and abundant facilities are already available for producing them in large numbers.

The animals are being genetically engineered with added human genes to prevent their organs from being rejected by the human immune system.

Tests have already shown that pig tissue with the added genes is protected against the first and most violent form of rejection, normally

caused by the part of the immune system known as complement, reports 'Spectrum' science journal.

More than 40 transgenic pigs, carrying a human gene which protects against complement, have already been produced.

Heart Valves

At Hancock Laboratories in Anaheim, California, technicians “bioplasticize” heart valves from commercially slaughtered hogs and mount them in a doughnutlike stainless-steel and Dacron frame for implantation in human patients. The device virtually eliminates blood-clotting problems associated with mechanical artificial valves. More than 60000 people walking alive today because of a piece of pig in their chest.

Organs

Pigs are likely to be used as donors for kidneys, hearts and other organs, for which there is an acute shortage. Transplant surgeon, Mr. John Wallwork, Director of the Transplant unit at the well-known Papworth Hospital near Cambridge, says that about 2000 people receive organ transplants annually in the United States. There is a wide gap between the availability of organs and demand and they believe that only pig donors can close the gap. The use of pig organs can put an end to the unethical practice of the impoverished selling kidneys to rich recipients in need of them.

Insulin and other hormonal products

Many valuable products are being extracted such as insulin for diabetics, heparin for anticoagulation of blood, thyroxin to treat underactive thyroids and ACTH, a pituitary gland hormone used to combat the pain of such afflictions as arthritis, leukemia and rheumatic fever.

1.7 Ideal Model for studies on human alcoholism

The pig is the ideal model for studies on human alcoholism. It is the only mammal other than man that will voluntarily drink enough alcohol to be classified as an alcoholic. Most of the alcoholic pigs consume on an average, the equivalent of one quart of 86-proof vodka a day.

2. HISTORY AND ORIGIN OF PIGS

Man has reared pigs for meat in Europe and Asia since neolithic times and well developed pig cultures still exist in parts of Indonesia. The wild boar has been domesticated separately in Europe, India, China and Malaya.

2.1 Domestication of Pigs

The majority of the pig breeds are descended from the Eurasian Wild Boar (*Sus scrofa*). Archaeological evidence from the Middle East indicates domestication of the pig occurs as early as 9000 years ago. There is some evidence for domestication even earlier in China. Figurines, as well as bones, dating to the sixth and seventh millennia B.C. have been found at sites in the Middle East. Pigs were also a popular subject for statuettes in ancient Persia.

2.2 Pigs in Europe and Asia

From Middle East, the pig spread across Asia, Europe and Africa. One interesting point, while most livestock were utilized initially by nomadic peoples, pigs are more indicative of a settled farming community, because pigs are difficult to move for long distances. The ancestors of the domesticated pigs are found among the Palaearctic, Indian and Malaysian wild pigs of the species *Sus scrofa*.

2.3 Pigs in Egypt

In the 19th century it was still customary in Egypt to rear young wild boar together with horses to keep the horses in health. The ham was fed to the camel to restore its sight. At the end of 15th century the Venetians had to pay a considerable sum of money for the privilege of keeping a pig at their factory in Alexandria. In Graeco-Roman times pigs were bred in large numbers throughout Egypt and a tax was imposed upon them.

At the time of the New Kingdom pigs were bred in considerable numbers throughout the Nile valley. In the tomb of Renni, who was mayor of El-Kab, occurs the earliest representation of domesticated swine in an agricultural scene. It is recorded that Renni possessed 100 sheep, 1200 goats and 1500 pigs. In the tomb of Paheri, also at El-Kab, a swineland is

figured with a drove of pigs. In three tombs of the XVIIIst Dynasty at Thebes (c.1570- 1305 B.C.) swine are again depicted in agricultural scenes, and in two of these the pigs are shown being driven over fields of newly sown corn to tread it in, a custom that still prevailed in Egypt a thousand years later when Herodotus visited the Nile valley (Newberry, 1928). In an Egyptian alabaster group, excavated at Gezer in Palestine, a man is represented carrying a pig (Micalister, 1912). In the region of Seti I (1302-1290 B.C.) pigs were bred in the temple domains at Abydos.

2.4 Pig in Ancient India

In early Indus-valley civilization, Piggott (1950) includes the pig- *Sus cristatus* var. domesticus - among the domestic animals represented at Harappa in the Punjab at the end of the 3rd millennium B.C. The Indus economy like the Egyptian and Mesopotamian, rested on irrigation farming. Wheat, barley, dates and possibly rice, were cultivated, while cotton took the place of flax. The pig was present in large numbers from the earliest times when Mohenjo-Daro was a flourishing city.

A recent find of a neolithic tool factory in the province of Madras in southern India, and a rock painting of a chariot drawn by four onagers at Morhana Pahar, Mirzapur district, referred by B. and R. Allchin (1968) to the late stone age of western India, suggest that pig was present in our ancient culture.

3. PIGS IN ART AND CULTURE

3.1 Pigs in Art

3.1.1 “Varahavatara”- Incarnation of God “Vishnu”

The God “Vishnu” took the form of a gigantic wild boar 40 miles wide and 4000 miles tall to dive to the bottom of the ocean and recover the earth, which was submerged by demons. Vishnu in the form of “Varahavatara” wild boar dashed across heaven and dived onto the waters where he tracked down the earth by his sense of smell. He killed the demon “Hiranyaksha” and came up to the surface of the water, bringing with him the earth which he lifted from the abyss on his tusks. The sculptures represented the “Varahavatara” in the form of a giant with the head of a boar, holding in his arms the goddess of Earth.

Varaha Cave in Mahabalipuram

The early phase of Pallava architecture and sculpture is at Mamalapuram (Mahabalipuram), 35 miles south to Chennai, where there are rock-cut cave temples, monoliths and structural buildings. Cave I (Varaha Cave) contains the sculpture of “Varahavatara” of Lord Vishnu to save earth from submerging from sea.

Varaha Temple in Khajuraho (Madhya Pradesh)

The small village of Khajuraho is situated in Madhya Pradesh at a distance of 44 km from Chattarpur district. The huge Varaha Image in the Varaha temple, with hundreds of other deities carved on it, with a Naga worshiping it and Prithvi, whom he had rescued, carved on the same pedestal, depicts the Varaha incarnation of Lord “Vishnu”.

The temple is 20 feet 6 inch by 16 feet with a boar statue standing in the middle is 8 feet 9 inch long, 5 feet 9 inch high carved of a single block of stone. A number of Hindu Gods and Goddesses are carved all over the body and head of the boar. The figure of “Prithvi”, whom the deity had rescued from the depths of the ocean with his left tusk, is broken off but traces of her feet still remain on the pedestal. A serpent deity (Naga) in devotional attitude is shown beneath the boar.

The “Varahavatara” is mostly depicted in standing posture



Fig.3.1.1.1 “Varahavatara” from Mahabalipuram

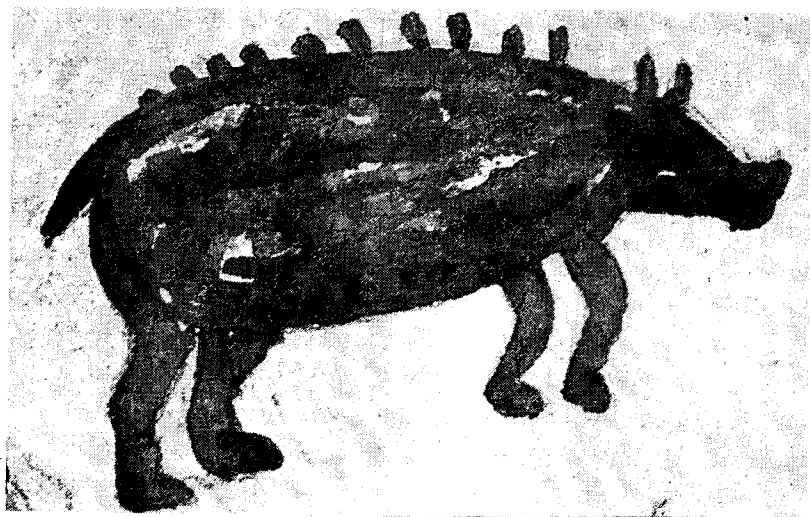


Fig.3.1.3.1 Boar in Rock Paintings at Bhimbetka

with the image of “Prithvi” sitting on the elbow of his left hand while he is only looking at her. The Varahavatara images of Khajuraho resemble the Varaha stone of Phalodi (Jodhpur dist. of Rajasthan) belonging to the Chalukya-Pallava period.

3.1.2 Wild Boar- in Indus Valley Civilization

A toy modeled on a wild boar has been recovered from Mohenjo-Daro. The remains of pigs were also found at Mohenjo-Daro. “The pig was present in large numbers in this area from the very earliest time when Mohenjo-Daro was flourishing city,” states Marshall. “But it is impossible to determine whether or not this animal was actually domesticated or even whether it was used as a source of food by the inhabitants in those far-off times. At the present time, pigs are the common occurrence throughout these parts, and it is possible that in the old days they existed in large herds that roamed the countryside searching for food.

3.1.3 Boar in Rock Paintings at Bhimbetka

A study of rock paintings at Bhimbetka reveals that primitive men had a very good notion of the animals’ habits and even their anatomy. The poses of animals represented are very natural and the wounds depicted are such as to be unerringly lethal.

The pre-historic people were first human beings probably lived about 2 million years ago. But people begin to record history when they had invented writing- only about 5500 years ago. The period before human beings learned to write is called prehistory. The pre-historic people were all hunters. They were strong, patient, agile and skillful, but their hunts were not always successful. The wild animals were also strong and cunning. They thought that if they drew up an animal and then “killed” the picture, the hunts proper would be nothing but a formality. Gradually this “preliminary hunt” acquired more and more complex attributes, with special songs and dances devised for the purpose. Many animals specially hunting scene including the drawing of Wild boar is depicted in cave paintings of Bhimbetka (India).



Fig. 3.1.5.1 Wild boars in Kota Paintings



Fig.3.2.3.1 Pigs in Tribal Culture

Varahavatara in National Museum, New Delhi

Varaha is also depicted in the collection of National museum, New Delhi.

Varahi in Indian museum, Calcutta

Varahi an incarnation of God Vishnu is also depicted in the collection of Indian Museum, Calcutta.

3.1.4 Pigs in Old rock Paintings

A recent find of a neolithic tool factory in the province of Madras in southern India, and a rock painting of a chariot drawn by four onagers at Morhana Pahar, Mirzapur district, referred by B. and R. Allchin (1968) to the late stone age of western India, suggest that pig was present in our ancient culture.

3.1.5 Wild Boar in Kota Paintings

Wild Pig is regarded as one of the most bravest and interesting Hero of "*History of Shikar*". It is shown in old historical paintings and many of these paintings are preserved in the Indian Museums. Kota paintings contains the beautiful representation of wild boar, which is shown in Fig.3.1.5.1.

The rulers of Kotah were connoisseurs in the art of "Shikar" or hunting. A hunting scene of A.D. 1778 of Kotah paintings shows that for all Rajputs, the symbol of bravery in the animal kingdom is the wild-boar and not the lion or the tiger. The wild boar meat was considered a great delicacy in Rajput cuisine. No culinary feast, in season was considered complete without the spiced tenderly grilled kebabs called "soola" served in the repast.

3.1.6 Egyptian Representations of Pigs

Small models of swine in clay have been found in predynastic graves at Abydos and in Upper Egypt. A group of six pigs formed in clay was recovered from a prehistoric grave at El Amrah. Quibell (1900) found a faience figure of a boar in the oldest strata of the temple of Hierakonpolis. A running boar hieroglyph occurs on several seal cylinders of the Ist Dynasty (Petrie, 1920). Swine are mentioned in the inventory of Thutinekht's possessions (c. 2200 B.C.).

At the time of the New Kingdom pigs were bred in



Fig.3.3.1.1 Pig sticking in India



Fig.3.3.2.1 Hunting of Wild Boar

considerable numbers throughout the Nile valley. In the tomb of Renni, who was mayor of El-Kab, occurs the earliest representation of domesticated swine in an agricultural scene. It is recorded that Renni possessed 100 sheep, 1200 goats and 1500 pigs. In the tomb of Paheri, also at El-Kab, a swineland is figured with a drove of pigs. In three tombs of the XVIIIst Dynasty at Thebes (c.1570- 1305 B.C.) swine are again depicted in agricultural scenes, and in two of these the pigs are shown being driven over fields of newly sown corn to tread it in, a custom that still prevailed in Egypt a thousand years later when Herodotus visited the Nile valley (Newberry, 1928). In an Egyptian alabaster group, excavated at Gezer in Palestine, a man is represented carrying a pig (Micalister, 1912). In the region of Seti I (1302-1290 B.C.) pigs were bred in the temple domains at Abydos.

3.2 Pigs in Social Culture

3.2.1 Pig Culture in Egypt

The “pig culture”, a strong and complex culture is exists in New Guinea.

The Domestic Pig in Egypt

In the 19th century it was still customary in Egypt to rear young wild boar together with horses to keep the horses in health. The ham was fed to the camel, to restore its sight. At the end of 15th century the Venetians had to pay a considerable sum of money for the privilege of keeping a pig at their factory in Alexandria. In Graeco-Roman times pigs were bred in large numbers throughout Egypt and a tax was imposed upon them.

Pig in Ancient Egypt Religion

A black pig smote the eyes of Horus and blinded him, and the passage of black pig over a tile defiled it. in the “Book of Gates” the black pig is seen in a boat being driven away by a baboon (Budge, 1934). In the Papyrus of Nekht is a chapter entitled “The Chapter of Repulsing the Pig”, and the accompanying vignette represents the deceased piercing a pig with a spear (Budge, 1923). Herodotus recorded that swine-herds were the most despised class in Egypt. They were forbidden to

enter any temple, and they were the only men who were thus excluded. No one would give his daughter in marriage to a swineherd, or marry a swine-herd's daughter. The swineherds married among themselves. If a man so much as touched a pig, he had to step into the river with his clothers on, to wash off the taint. To drink pig's milk was believed to cause leprosy (Frazer, 1925).

Pig was also regarded as sacred by the ancient Egyptians. Pork was eaten for sacramental purposes. Herodotus narrates that swine were sacrificed to the moon-god and to Dionysos (Osiris) at the season of the full moon, and Plutarch reported the sacrifice of a sow to Typhon (Set) sacred to isis, and small figures of sows were worn as amulets attached to necklaces. The Greek astronomer and mathematician Eudoxus was of opinion that the Egyptians spared the pig, not out of abhorrence, but from a regard to its utility in agriculture, for when the Nile subsided, herds of swine were turned loose over the fields to tread the seed down into the moist earth.

3.2.2 Pigs in North-Eastern States of India

Pigs had played a special significant role in the north-eastern region of India. The rearing of pigs is related to their culture and every household of the north-eastern region rears pigs.

3.2.3 Pigs in Tribal Culture

Tribal population of India rears pigs from pre-historic times and is a part and parcel of their culture.

The tribes of India constitutes nearly 8% of the total population are the earliest inhabitants of the country. The Hindi word for tribe is "Adivasi", which means Adi=original and Vasi=inhabitants.

3.2.4 Pigs in Rajpoot Culture

The wild boar was sacramentally eaten by the Rajputs, indicating the dualistic attitude towards the pig. Wild pigs are of common occurrence throughout these parts, and it is possible that in old days they existed in large groups that roamed the countryside in search of food. At the present day in and around

the city of Bikaner in the Rajputana desert the wild boar thrives, and each night large numbers of them wander into the city to feed on the refuse and other matter that has been thrown out by the inhabitants.

3.2.5 Pigs in Africa

In Western Equatorial Africa, the Bateke of Gabon are exceedingly fond of pigs, not necessarily to rear, but as pets. A favorite boar may be the friend of the whole village, and come readily to call to be fed or played with.

3.2.6 Pigs in Indus-valley Civilization

In early Indus-valley civilization, Piggott (1950) includes the pig- *Sus cristatus domesticus* - among the domestic animals represented at Harappa in the Punjab at the end of the 3rd millennium B.C. The Indus economy like the Egyptian and Mesopotamian, rested on irrigation farming. Wheat, barley, dates and possibly rice, were cultivated, while cotton took the place of flax. The pig was present in large numbers from the earliest times when Mohenjo-Daro was a flourishing city.

3.2.7 Wild Boar in England

In England, during the ruling of Norman kings, anyone who killed a wild boar without royal permission might have his eyes put out.

3.2.8 Wild Boar in Europe

Some great estates in Europe still keep wild boar in their woods to hunt. Sports enthusiasts consider boar hunting on foot with hounds and spears exciting and dangerous.

3.3 Hunting of Wild Boar

3.3.1 Pig-sticking in India

Hunting of wild boar has been a favorite sport of Rajpoot kings and nobles from earliest times. The boar's head was brought into the dining halls with great ceremony in ancient and medieval times. The method of hunting of wild boar was preserved in the shape of paintings. Hunting of wild boar was one of the favorite subject of Rajpoot paintings. The larger boar was hunted on horseback. The hunter carried a spear and killed the boar by charging it, which was called "*pigsticking*" in India.

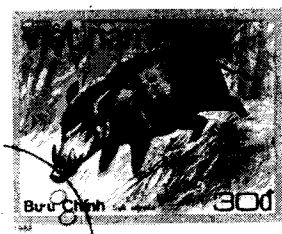


Fig. 3.4.1 Pigs in Postage Stamps

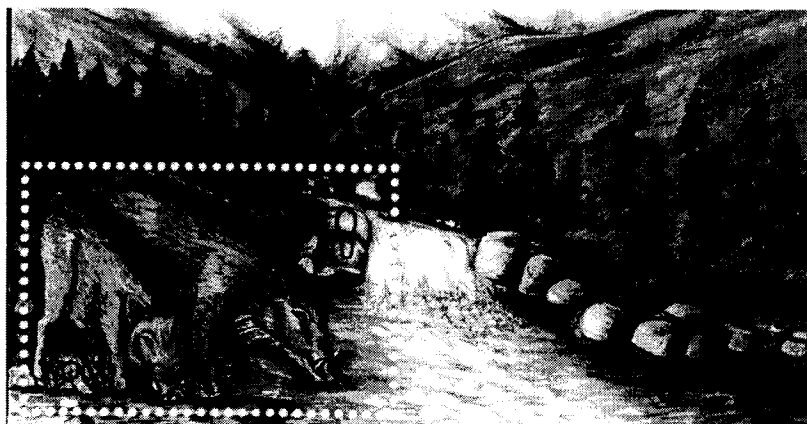


Fig.3.4.2 Celebration of “Wood Hog Year”.

3.3.2 Hunting of Wild Boar in England

Wild boar hunting was an important sport activity during ancient times in England. During the ruling of Norman kings, anyone who killed a wild boar without royal permission might have his eyes put out.

3.4 Pigs in Postage Stamps

Wild pig is the ancestor of domestic pig and it is closely related with many cultures of the world. The pig diversity which has evolved over a period of 12000 years, has been captured in postage stamps, carrying various social, cultural and historic messages for preservation of wild boar. The wild boar's glorious heritage has been beautifully depicted in the philatelic stamps issued over the years by many countries.

Sus Scrofa (Linnaeus, 1758) The Wild Boar

Under NATURE series of 6 stamps issued by Belgium in 1998, the 17 BEF value stamp attracted the interest of philatelists.

The most indigenous species of domestic pig are oriented from wild boar. Unfortunately, a great number of wild boars are directly or indirectly threatened. Man has a generally negative influence on the environment of indigenous animals. The clearing of forests deprive some species of their habitat and food. The wild boar-emblem of the Ardennes is the animal from which the domestic swine is descended. It was domesticated in the 9th or 8th century B.C.

Wood Hog Year-1995

The "Wood Hog Year-1995" was celebrated by Bhutan, by releasing one beautiful postage stamp on wild boar along with a poem of "Thoedora Lau" on Wild Boar, which is as under:-

*Of all God's Children
I have the purest heart
With Innocence and faith,
I walk in Love's protective light.
By giving of myself freely
I am richer and twice blest.*



Fig.3.5.1 Boar on Coins

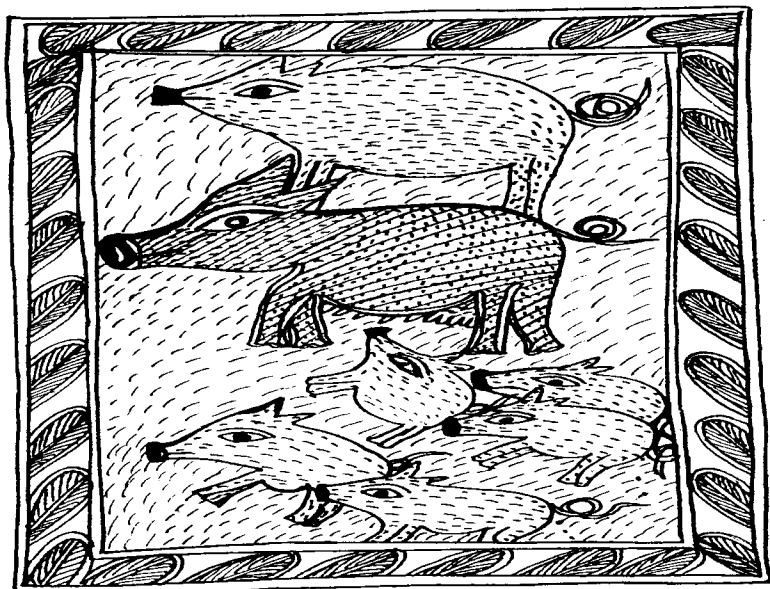


Fig.3.8.1 Pigs in Madhubani Paintings

***Bonded to all mankind by
Common fellowship,
My Goodwill is Universal
And knows no bounds.
I AM THE BOAR.***

Many countries viz Afganistan, Hungary, USSR, Mongolia, Romania, Poland and Vietnam had respected wild boar by issuing postage stamps on *sus scrofa*.

Respect for nature remains the simplest means to prevent the extinction a species, which, unfortunately, is an irreversible phenomenon. Acting while there is still is time to act, promoting any action aiming at making public opinion aware of the problem remain the first engagements into which one should enter. The issue of postage stamps may contribute to that.

3.5 Boar on Coins

The king Bhoja, who ruled from A.D.836 to A.D. 882 was the most renowned king of Northern India. He issued some coins with a picture of “*Varaha*”, incarnation of God “*Vishnu*” and he also took the title of “*Adivaraha*”.

3.6 Trials of Pigs

Trials of animals were common occurrence up to the eighteenth century. Animals, birds, reptiles and insects were put on trial, the defendants were strictly interrogated, and even tortured, counsels for the prosecution and the defence were given a chance to plead their case before the judges. In 1268, a young pig who maimed a child was convicted. In the 13th century, a pig was sentenced to hanging in France for devouring her litter.

3.7 Ancient agriculture system

The farmers of the ancient days were aware of the fertilizing properties of the flesh of the animals, fish-washings and farm-yard manure consisting of the excreta of various animals. The “*Brihatsamhita*” says that seeds are to be sown with the addition of pork or venison into the soil and sprinkled daily with water mixed with milk.

3.8 Pigs in Madhubani Paintings

Pig is one of the subject in Madhubani paintings of Bihar (India). A sow with her piglets are shown in one painting painted by Madhubani folk painter (Fig. 3.8.1).

3.9 Pig in Sacramental Sacrifice

A pig meets with ritual slaughter in a 2,500 years old Greek vase painting. Swine, both wild and domestic were linked with deities in ancient culture around the world. The pig was used in sacramental sacrifices.

3.10 Pig in Masterpiece of the Limbourg Brothers

The masterpiece of the Limbourg brothers, the manuscript known as *Les Tres Riches Heures du Duc de Berry*, was begun in about 1413 and left unfinished in 1436, when the Duke and the artists died. The most remarkable feature of the manuscript is the series of the full-page illustrations of the months. A painting representing month of November, only the semicircular top of the illustration was painted by the Limbourgs and painting showing a peasant throwing a stick to bring down acorns for the pigs was painted by Jean Colombe.

A boar hunt is shown taking place in the forest of Vincennes, overlooked by the Chateau de Vincennes, where the Duc de Berry was born in 1340. This image is significantly remarkable for its comprehensive view of nature, embracing beauty and cruelty alike.

4. MEAT AND HUMAN NUTRITION

4.1 The Food Animals

The food animals which furnish meat for human consumption are drawn mainly from those which consume plant food, such as hay, straw, roots or grain. Although, over 4000 species of mammals and 19 different orders, which have been used for the production of meat. But due to restriction\ ban on hunting, only few domesticated species have been regularly used for food. In India, the bulk of the meat is derived from sheep, goat, cattle, buffalo and pigs. In addition, hens, ducks, goose and turkeys have become major commercial meat producing species. Rabbits, guinea pigs and other game animals and birds provide a substantial amount of protein. Rabbits form a subsidiary but important source of meat due to the their quick turnover and high feed conversion efficiency. Fish, shrimps, prawns, mollusks and other sea foods have also been an important part of man's diet since earliest times.

4.2 Meat Production in India

In India, animals are not reared for meat, and meat is the by- product of the animal industry. The cattle and buffaloes are being used as a source of milk and draught power. The sheep are reared for wool and when they outlived their productive life, they are slaughtered. However, pigs and male goats are reared for meat alone whereas the poultry is reared for eggs and meat. In India, modern meat breeds of poultry and pigs are available for breeding and improvement of Indian breeds.

4.3 Future of Meat Products

The future of meat and meat products will depend mainly on consumer demand and the prices at which they can be profitably produced. The urbanization and rise of living standard, cost of production and processing, feed conversion efficiency, availability, consumer preference, taste and diet would play a part in determining future demands.

4.5 Meat & Meat Products

Meat is the dressed flesh derived from cattle, buffaloes, sheep, lambs, goats, pigs and poultry. Beef refers to meat from

cattle; veal to that from calves; pork to that from pigs; lamb to that from young sheep; and mutton to that from sheep over one year old. Besides the dressed meat, certain parts of the carcass and their organs called “offals” are also sold as meat. Edible offals include tongue, pancreas, kidneys, heart, liver and stomach. Inedible offals include the hides, hair, bones, horns and hoofs. Blood and fat may be used for both edible and inedible purpose. The meat of rabbit, horse, goat and deer are regularly consumed in some countries and various other mammalian species are eaten in other parts of the world. Seal and polar bear are included in the Eskimo diet. Rhinoceros; hippopotamus and elephant are occasionally consumed by the tribes of the Central Africa.

4.6 Pork and Pork Products

Pork is very important source of animal protein for the human diet. Modern pork processing can play a significant role in the supply of protein and nutrients of animal origin. Pork is an excellent source of high quality protein, B-Vitamins and trace elements. It is nutritionally balanced and palatable food. The pork has been known to play a key role in providing a good and cheap source of essential nutrients to man.

4.7 Pork and Human Nutrition

The purpose of good nutrition is to promote health and general well being. However, the nutritional quality of meat and meat products is normally measured in terms of its ability to satisfy human nutrient requirements. The availability and abundant supply of nutrients provided by meat and other animal products is known to us since prehistoric times. The importance of meat and other animal products, such as fish, poultry and dairy products, to the human diet is well established and the meat has been known to play a key role in providing a good source of essential nutrients to man. The nutrient composition of the meat product depends on the raw meat, as well as the effects of processing and storage.

The most significant contribution which foods of animal origin make to human nutrition is in the high quality proteins

they supply. Proteins are essential for human nutrition. In addition to providing the essential amino acids, which synthesizes proteins also serve in the form of nucleoproteins and enzymes, as the activator of vital processes such as reproduction, cell growth, maturation and genetic activity. Meat is a competitor of other high protein foods of animal origin, such as cheese, eggs and fish. We are well aware of the high nutritive value of foods derived from animals. There is no controversy about the role of animal products in providing valuable sources of energy, protein, essential amino acids and a variety of essential nutrients. The value of dairy products as sources of calcium and riboflavin and the value of meat products as sources of niacin, iron and trace minerals is undisputed.

Meat and meat products are readily and rapidly digested. Foods of animal origin are devoid of anti-nutritive factors, frequently found in foods derived from plants: phytic acid, oxalic acid, goitrogenic substances, antitryptic factors, carbohydrates causing flatulence, phenols etc. Some of these interfere with the absorption of trace minerals, particularly zinc, hence, the trace elements contained in animal products are considered totally bio-available.

4.8 Pork in Human Nutrition

The nutrients are commonly divided into the following classes: proteins, fats, carbohydrates, minerals and vitamins. All these classes of nutrients is vital to the human body and occurs in the flesh foods. The discussion will be focused on more important ones provided by meat and meat products and their deficiency levels in the production of disease.

PROTEIN

Proteins can be mainly classified on the basis of their physical properties. They are divided into: (i) simple proteins, which yield amino acids or their derivatives on hydrolysis, (ii) conjugated proteins, which are simple protein containing a non-protein radical, such as nucleic acid, a carbohydrate, phosphorous, haematin or a lecithin group and (iii) derived proteins, which are altered proteins as a result of the action of

heat enzymes or chemical agents. Raw meat contains only the first two classes of protein, although cooked and processed meat and meat products may also contain the derived proteins. Meat products are the excellent sources of protein, not only from the standpoint of the quantity but also the quality of protein. Flesh foods usually contain all of the essential amino acids, which include lysine, isoleucine, phenylalanine, alanine, valine, threonine, methionine and tryptophan. Most of the vegetable proteins are lacking in one or more of the essential amino acids and may therefore be classified as incomplete proteins.

Proteins also play important roles in growth and maintenance of the integrity of body structure and functions. Kwashiorkor and marasmus are common nutritional manifestations of the protein and protein calorie deficiencies in infants and children and can also occur in adults. However, protein malnutrition is more likely to occur with infants, children and pregnant women than in other population groups.

FATS

The amount and composition of fats in the animal body is highly variable, depending upon the species and the diet. The fat content increases as the animal grows from birth to maturity. The lipids in the meat products can be classified as: (i) triglycerides or fats, (ii) esters of long chain fatty alcohols, (iii) esters of phospholipids and, (iv) spingolipids which are found in small amounts in nerves and the central nervous system.

The lipid serves as a source of the essential fatty acids, such as arachidonic, linoleic and linolenic acid. Essential fatty acid function as precursors for prostaglandin synthesis and are essential components of membranes. Lipids also serve as carriers for the fat-soluble vitamins, aiding in their absorption from the digestive tract. Although meat products provide an abundant supply of lipids to prevent fatty acids deficiencies and to allow for the absorption of the fat-soluble vitamins. However, lipid deficiency is unlikely to occur, as the vegetable oils are generally richer sources of the essential fatty acids than animal fats.

There are major differences in composition of fat between

simple- stomach and ruminant species. Pork lard contains more unsaturated fatty acids, such as oleic acid, palmitic and stearic acids than ruminant fat. The detailed composition, however is much affected by the diet. Ruminant fat is more saturated, less variable in composition and less affected by the degree of saturation of fatty acids of the diet, because of the extensive hydrogenation of unsaturated fatty acids by rumen microorganisms. There are major differences in the properties of fat, i.e. softness, melting point and susceptibility to oxidative rancidity. In older animals there is more fat within and between muscles, while meat from young animals almost devoid of fat.

CARBOHYDRATES

The carbohydrates provide a major source of energy for man, but are found only in very limited amounts in meat and meat products. Carbohydrates can be classified as: (i) monosaccharides, i.e. pentoses or hexoses, (ii) disaccharides, which are present only as additives in meat products and (iii) hexosans, which include glycogen and starch. The only pentose found in the flesh foods is ribose, which is present in only small quantities. Glucose is produced by the oxidative breakdown of glycogen, but under anaerobic conditions it is converted to lactic acid.

MINERALS

The minerals are classified as the essential and nonessential elements. The essential elements can be further divided into macro and micro elements based on the relative amounts needed by the body. The macroelements include calcium, phosphorus sodium, chlorine, potassium, sulphur and magnesium. The trace elements include iron, copper, iodine, manganese, zinc, cobalt, selenium, nickel, chromium, molybdenum, fluorine, vanadium, arsenic and silicon.

Calcium and phosphorus account for over 70% of the mineral content of the body. About 99% of the calcium and 80% of the phosphorus are in the bones and teeth. The remaining 1% of the calcium is distributed in the other tissues. Calcium and phosphorus required in the diet at adequate levels to meet

body requirement for maintenance, growth, pregnancy and lactation. Calcium and phosphorus are constantly being mobilized to maintain the blood levels needed to regulate body functions. Calcium plays an important role in blood coagulation, functions in muscle contraction and is required to activate a number of body enzymes. Phosphorus is a component of ATP and plays significant role in energy transformation. Meat products are good sources of phosphorus, but generally low in calcium. Dairy products are practically high calcium rich food in the human diet. Calcium is vital for the formation of bone in children and for the maintenance of bone health in adults.

Sodium, chlorine and potassium occur in all fluids and soft tissues of the bodies. These minerals play important functions in water metabolism. Sodium is localized in the extracellular fluids and plays a key role in the regulation of neutrality. It is very low in blood cells, but occur in fair amounts in muscle. Very low levels of sodium result in retarded growth and lower utilization of digested protein and energy. Chlorine is found in organic combinations. The chlorides in blood regulates acid base equilibrium. It is also a constituent of gastric juice, being present both as free acid and in the form of salts. Potassium is primarily a cellular constituent. It is so widely distributed in foods, especially in plant products, that deficiencies are seldom encountered on natural diets.

Sulphur is present in proteins, as the sulphur containing amino acids and it also occurs in a number of other biologically important compounds, such as insulin and glutathione. The meat products seem to serve an important function in supplying the body with its sulphur requirements. Magnesium is found in skeleton and body fluids. It plays an important role in carbohydrate metabolism and activates the enzyme, phosphatase. Flesh foods tend to be low in magnesium.

Iodine is present in thyroxine form, a hormone of the thyroid gland, responsible for the regulation of basal metabolic rate. Meat products are poor source of iodine. The use of iodized salt has been shown to effectively prevent goiter. Manganese is found

in the extremely small amounts with the principal store being in liver. The appreciable amounts are found in kidneys, pancreas, muscle and sex organs. The low level in the diet has a marked influence on reproduction. Zinc is widely distributed in bone, hair, liver, pancreas, kidney and muscle. The meat proteins are better sources of dietary zinc than plants since the phytate present in many plant sources complexes the zinc and makes it unavailable.

Cobalt is present as vitamin B₁₂. It is found in organ meat such as liver and kidney. The deficiency of cobalt is responsible for anaemia in both children and pregnant woman. Selenium occurs in all cells and tissues of the body, with liver and kidney having the highest concentration. It is a constituent of the enzyme glutathione peroxidase which performs a vital tissue function. Fluorine is normally very low in the soft tissues of the body but tends to be concentrated in the bones and teeth. It is known to be essential for growth and reproduction, its use for inhibiting dental caries is well recognized.

VITAMINS

The vitamins although required in extremely small quantities, play vital roles in the health. The vitamins are divided into two groups, the fat soluble and water soluble vitamins. The fat soluble group include vitamins A, D, E and K, while the water soluble group includes vitamins C, B₁ or thiamine, B₂ or riboflavin, niacin, Vitamin B₆ or pyridoxine, pantothenic acid, biotin, choline, folic acid and vitamin B₁₂.

Vitamin A

It is necessary for the growth and general well being of the young children and women. It is formed from yellow carotene, found in carrots, green vegetables, egg yolk, fish liver oil, butter, cream and cod liver oil. It plays an important role in photoreceptor mechanism of retina, integrity of epithelia and lysosome stability. Deficiency symptoms in man causes night blindness; Xerophthalmia.

Vitamin D

It is found as ergocalciferol (D₂) and cholecalciferol (D₃)

is the anti-rachitic principle found in cod liver oil, meat juice, cow's milk and egg yolk. It is essential for calcification of bones and calcium and phosphorus absorption. The deficiency of this vitamin causes rickets in children.

Vitamin E

Vitamin E or tocopherol is a fat soluble vitamin and found particularly in germ of wheat and red meat. It is necessary for fertility and reproduction. It also acts as intracellular antioxidant and helps in stability of biological membranes.

Vitamin K

Vitamin K is found in leafy vegetables, pork, liver and vegetable oils. It plays an important role in normal blood coagulation. Its deficiency causes delayed prothrombin formation.

Thiamine (Vitamin B₁)

It is found in dried yeast, whole grains, meat such as liver and pork, legumes and potatoes. It is essential for carbohydrate metabolism, central and peripheral nerve cell function and myocardial function. Deficiency in man produces beriberi disease.

Riboflavin (Vitamin B₂)

Riboflavin is a constituent of the flavoproteins- hydrogen transporting enzymes, concerned with the energy metabolism. It is found in milk, cheese, liver, meat, eggs and enriched cereal products. Deficiency symptoms in man results in cheilosis, angular stomatitis and sebaceous dermatosis.

Niacin (Nicotinic acid)

It is found in dried yeast, liver, meat, fish and legumes and whole grain enriched products. It is responsible for oxidation-reduction reaction and carbohydrate and tryptophan metabolism. Deficiency symptoms in man produces pellagra. The beneficial effects of eating flesh foods have been widely recognized as helping in eliminating pellagra.

Vitamin B₆ Group

This group includes pyridoxine, pyridoxal and pyridoxamine. These are found in dried yeast, liver, organ meat,

whole grain cereals, fish and legumes. It is essential for cellular function and for metabolism of certain amino and fatty acids. Deficiency symptoms may show anaemia and skin lesions.

Pantothenic Acid

It is a water soluble vitamin, involved in fat, protein and carbohydrate metabolism. It is found in dried yeast, liver, eggs, organ meats and legumes. Deficiency symptoms in man may lead to fatigue, headache, sleep disturbances, vomiting and impaired coordination.

Folic Acid

It is found in fresh green leafy vegetables, fruit, organ meats, liver and dried yeast. It is responsible for maturation of red blood cells and synthesis of purines and pyrimidines.

Vitamin B₁₂

This vitamin contains cobalt and is also known as cyanocobalamin. It is the anti-pernicious anaemia factor in man. It is found in liver, meats such as beef, pork, organ meat, eggs, milk and milk products. It is essential for maturation of RBC's, DNA synthesis, related to folate coenzymes, methionine and acetate synthesis.

Vitamin C

Vitamin C or ascorbic acid is found in the juices of citrus fruits, tomatoes, potatoes, cabbage and green pepper. It is essential to osteoid tissue, collagen formation, vascular function and wound healing. Deficiency symptoms in man result in scurvy (hemorrhages, loose teeth and gingivitis).

4.8 Effect of Processing on Nutrient Content

The effect of processing is normally considered in terms of their detrimental effects on the nutrient composition of food. There are, however, some beneficial effects. Meat products are processed to improve their sensory qualities, to destroy pathogenic organisms and to increase the shelf life.

4.9 Pork and Cholesterol

Cholesterol is a waxy, fat like substance present in the body and is circulating in blood. It does not dissolve in the blood plasma. It is very essential to life. It is a precursor of many

substances such as bile acids, male and female sex hormones and adrenal cortical steroid hormones. Cholesterol is also essential for the formation of healthy cell membranes. It is found only in food of animal origin, such as meat, cheese, eggs, milk, cream and animals fats. It is an essential body substance which forms the basis of several hormones, but if present in excess can cause blockage in the arteries, which can lead to heart disease. It is also been found to play some role in cancer of colon, stomach and breast.

4.9.1 Lipoproteins and their Role

The total content of cholesterol in the body is about 140 g, of which about 120 g is present in membranes. Since the body is in a dynamic state, all body cells must be constantly provided with cholesterol. A constant supply is ensured by the dietary intake of the cholesterol and biosynthesis of cholesterol in the liver. Once the cholesterol comes out of the liver, it is in the form of lipoproteins. Lipoproteins help to regulate blood cholesterol levels. They are the combination of lipids (fats), cholesterol and proteins. They are the carriers of cholesterol, as it can not dissolve in blood. Three types of lipoproteins are produced, High density lipoproteins (HDL), low density lipoproteins (LDL) and very low density lipoproteins (VLDL).

HDL is a good cholesterol, because it carries cholesterol away from blood vessels to liver, where it is eliminated. LDL is a bad cholesterol, because it tends to keep cholesterol in blood vessels, resulting in fatty deposits. The function of the VLDL is to carry fat from the liver to other parts of the body. After unloading some fat, VLDL becomes LDL. The excess amount of dietary fat increases the production of extra VLDL for its transport, ending with large amount of LDL which sticks in the blood vessels and causes blockage if the amount of HDL is insufficient. A total cholesterol of less than 200 mg/dl is desirable and is key to a healthy heart. The levels of LDL should be less than 160 mg/dl and HDL should be more than 35 mg/dl. Levels of HDL are very important in the circulation as it prevents deposition of LDL level.

4.9.2 Saturated and Unsaturated Fats

Foods high in animal fats increases normal cholesterol production, while vegetable fats, such as polyunsaturated fats, have been shown to lower the cholesterol level. Unsaturated fats are primarily of plant origin and are liquid at room temperature. They are of two types, Polyunsaturated such as corn oil, sunflower oil, soybean oil and other vegetable oil; and Monounsaturated fats such as olive oil. Both types may help to reduce the blood cholesterol level. Meat and meat products, egg yolks and shellfish are very rich in cholesterol and saturated fats. However, the intake of cholesterol in the form of food products of animal origin has an insignificant effect on the concentration of cholesterol in the blood of healthy persons representative of the population in general.

4.9.3 Coronary Heart Disease

Coronary heart disease, remains the major cause of the death in men, aged 30 to 60, in most countries where a high standard of living is enjoyed. Dietary fat constitutes a large proportion of the total caloric intake. Dietary fats consist of mixed triglycerides which are formed by the esterification of glycerol with saturated and unsaturated fatty acids. Fats are said to be saturated if they contain a large proportion of saturated fatty acids, as compared with unsaturated fats which are rich in unsaturated fatty acids. Stearic acid is an example of a saturated fatty acid and linoleic acid of a polyunsaturated fatty acid. Linoleic and arachidonic acids are essential fatty acids, and must be diet to prevent the deficiency. Essential fatty acids are widely distributed in food items and generally distributed by the human race. Saturated fats are generally solids at room temperature, such as butter, ghee, hydrogenated oils like vanaspati and vegetable oils like palm oil and coconut oil. These tend to elevate the blood cholesterol level.

4.9.4 Why Does Cholesterol Level Increase?

Obesity and certain genetic or inherited factors can contribute to a high cholesterol level. However, on of the most common and controllable factors is diet. Large amounts of

dietary intake of cholesterol in the form of liver meat, meat products, cheese, butter, ghee and egg yolk cause excess of cholesterol and fats to accumulate.

4.9.5 Risk factors of Coronary Heart Disease

High blood cholesterol is regarded as one of many risk factors for cardiovascular disease. The cause of ischaemic heart disease is multifactorial. Among these, high blood pressure, cigarette smoking, heredity, stress or behavior, diabetes, age, sex, obesity and physical exercise are widely recognized. The serum cholesterol concentration can be lowered to the extent of about 8 to 9 % by drastic changes in the diet or by hypocholesterolaemic drugs in men with high blood cholesterol level. However, it has a very little effect on the incidence of ischaemic heart disease.

4.9.6 Effect of Dieting on Health

The total blood cholesterol often can be reduced by use of low fat and low cholesterol diet. However, it would result in a diet of lower nutritive value for most people. It is well known that proteins of animal origin have a significantly higher nutritive value than proteins of vegetable origin. Proteins of animal origin have a high content of each of eight essential amino acids. The amino acid balance in animal products is well adapted to all body functions. It has been estimated that to reduce cholesterol intake from an actual value of 600 mg/day to 300 mg/day, the consumption of animal products would have to decrease from 70 to 35 g/day per capita. This dieting would result in higher in fat and deficit in essential amino acids. The bioavailability of haem iron in meat is very high. In addition, the meat is known to enhance the absorption of iron contained in cereals or other plant foods. Pork, lamb, liver, chicken and beef increases the iron absorption. Reducing meat consumption in the diet would aggravate anaemia problems associated with iron insufficiency. Meat and meat products are essential components of a well balanced diet, and reduced consumption of such foods would be associated with risk of lowering the nutritional value of the diet with unpredictable results.

5. PRESENT STATUS

In spite of pig development programmes and implementing of a Centrally sponsored scheme by Ministry of Agriculture, Department of Animal Husbandry & Dairying "Assistance to States for Integrated Piggery Development", pig farming has not yet become popular to considerable extent. Consumption of pork and pork products has remained over the years very much restricted to a small section of the population except in North-eastern states, where pork is considered as staple food.

5.1 Population and Population Trends

The population and population trends of pig production is very important for planning effective developmental programs. The pig statistics at village, district and state level is essential to take up policy decisions. It also gives the basic data about the production for unit of commodity for formulating the sound pricing policy. At present the only source of pig population statistics is the quinquennial livestock census. As per the 1992 livestock census, the population of pig is highest in Uttar Pradesh, followed by Bihar, West Bengal and Tamil Nadu. In North-eastern states, the pig population is highest in Assam, followed by Manipur, Nagaland and Meghalaya.

Population Structure

The population structure comprising of indigenous, crossbred and exotic pigs is given in Table 5.1.1.

5.2 Population Trends, in India

The population trends of pigs as per Indian Livestock Census is presented in Table 5.2.1.

5.3 Pork Production in India

A total of 1.29 million pigs were slaughtered in 1997 to produce 452000 tonnes of pork and pork products. The yearwise estimated slaughter number and pork production is presented in Table 5.3.1. (FAO, 1997).

5.4 Pig Population of the World

The pig population based on the estimates of Food and Agriculture Organization of the United Nations (FAO) is presented in Table 5.4.1.

Table 5.1.1 Pig Population of India (ILC,1992) In 000

State	Cross-bred	Indigenous	Total Pigs
Andhra Pradesh	74	576	650
Arunachal Pradesh	7	230	237
Assam	299	1065	1364
Bihar	28	1099	1127
Delhi	4	6	10
Goa		89	89
Gujarat		102	102
Haryana	193	323	516
Himachal Pradesh		5	5
Jammu & Kashmir		12	12
Karnataka	38	342	380
Kerala	14	122	136
Maharashtra	29	347	376
Manipur	132	251	383
Meghalaya	102	193	295
Mizoram	73	39	112
Madhya Pradesh	15	714	729
Nagaland	244	282	526
Orissa	9	575	584
Punjab	35	66	101
Rajasthan	15	238	253
Sikkim	8	36	44
Tripura	12	176	188
Tamil Nadu	12	660	672
Uttar Pradesh	419	2486	2905
West Bengal	87	868	955
Andaman & Nicobar		34	34
Chandigarh		3	3
TOTAL	1849	10939	12788

Source:- Indian Livestock Census, 1992

Table 5.2.1 Pig Population Trends in India(1945-1992)

Indian Livestock Census	Total Pigs (in 000)	% change over last census
1945	3707	-----
1951	4426	19.40
1956	4934	11.48
1961	5176	4.90
1966	5035	-2.72
1972	6884	36.72
1977	7647	11.08
1982	10071	31.70
1987	10626	5.51
1992	12788	20.35

Source:-Indian Livestock Census1945-1992.

Table 5.3.1 Pork Production in India

Year	No. of pigs slaughtered (1000 head)	Pig Meat Production (1000 MT)	% increase in pig meat production over last year
1994	11650	408	-----
1995	12000	420	2.94
1996	12440	435	3.57
1997	12907	452	3.90

Source:- FAO Production Year Book,1996&1997, Vol.50-51.

Table 5.4.1 Pig Population in the World

Country	1995	1996	1997
World	901281	923949	936886
Africa	21585	21971	22168
Asia	511164	539180	557200
Bhutan	75	75	75
China	424681	452200	468055
India	14311	14855	15419
Indonesia	7825	8000	8200
Japan	10250	9900	9809
Malaysia	3282	3400	3400
Myanmar	2944	3229	3358
Nepal	636	670	724
Philippines	8941	9026	9750
Thailand	4507	4023	4209
Vietnam	16306	16921	17500
Europe	213106	209220	205011
Denmark	11084	10842	11100
France	14593	14800	14968
Germany	24698	23737	24283
Netherlands	14397	13958	14253
Poland	20418	17964	18135
Spain	18162	18555	18652
U.K.	7534	7496	7992
Australia	2653	2526	2684

Source:-FAO Production Year Book, 1997, Vol. 51

Table 5.5.1 Nos of pigs slaughtered and Pork Produced(1997)

Country	No. of pigs slaughtered (1000 head)	Pork Produced (1000 MT)
World	1146410	87873
Africa	16998	789
USA	91246	7727
Asia	675770	49962
Bhutan	33	1
China	566700	43275
India	12907	452
Indonesia	10900	600
Japan	103	1245
Malaysia	4400	241
Myanmar	2057	113
Nepal	364	12
Philippines	15953	1037
Thailand	6000	300
Vietnam	16133	1104
Europe	285316	23931
Denmark	19890	1523
France	25490	2265
Germany	39353	3475
Nederlands	14900	1310
Poland	20438	1724
Spain	27869	2190
U.K.	15373	1089
Australia	4640	325

Source:- FAO Production Year Book,1997, Vol.51

5.5 Pork Production Trends in the World

The pork production trends in the world based on the data of FAO is presented in Table 5.5.1.

5.6 Piggery Development in Plan Periods

Before the introduction of Five Year Plans, except for some sporadic import of a few superior quality of pigs of exotic breeds by a few missionary organisation, no concerted or organized measures were taken to improve pig production in the country.

FIRST FIVE YEAR PLAN (1951-56)

In the First Five Year Plan no attention was given to pig development.

SECOND FIVE YEAR PLAN (1956-61)

In order to develop pig production on systematic lines and organize it into profitable industry to the farmers, a Coordinated Piggery Development Programme was launched in 1959-60. Under this programme. By the end of Second Five Year Plan, Two Regional Pig Breeding Station, Two Bacon Factories and 15 Pig Breeding Units/farms and 33 Piggery Development Blocks were established.

THIRD FIVE YEAR PLAN (1961-66)

During Third Five year Plan 6 Bacon Factories, 5 Regional Pig Breeding Stations, 37 Pig Breeding Units/farms and 107 Piggery Development Blocks were established. The primary objective of the Regional Pig Breeding Station was to acclimatize and further improve the breeding stock of exotic pigs through selective breeding for distribution to pig breeding farms/units for further multiplication. The pigs produced at the breeding farms/units were to be distributed in compact rural areas for grading up the local stock. The bacon factories were to provide ready and remunerative markets for pigs raised and to produce for sale of pork and pork products under ideal hygienic condition.

FOURTH FIVE YEAR PLAN (1969-74)

During Fourth Five Year Plan, 3 Pig Breeding farms were set up for distribution of more piglets to Piggery development blocks.

The Indian Council of Agricultural Research (ICAR)

initiated an All India Coordinated Research Project on Pigs (AICRP on Pigs) during the Fourth Five Year Plan. The project sanctioned in October, 1970 started functioning early in 1971 with a major objective to develop suitable breed or breeds using imported stock.

FIFTH FIVE YEAR PLAN (1974-79)

AICRP on Pigs was continued during Fifth Five year plan with objective of evaluation of the performances of different breeds and breed combinations under different agro-climatic environments prevailing in the country. Exotic Breeds like Large White Yorkshire, Middle White Yorkshire, Landrace, Tamworth, Saddleback and Hampshire were maintained at Government Pig Breeding Farm with the objective of further improvement of the stock and distribution of improved piglets to farmers for rearing.

SIXTH FIVE YEAR PLAN (1980-85)

Exotic pigs was maintained in 99 state Government Pig Breeding farms in the country. Better quality of piglets was produced and distributed to farmers either for rearing as fatterer or establishment of small breeding units under the state programmes.

SEVENTH FIVE YEAR PLAN (1985-90)

AICRP on Pigs was continued during Seventh Five Year plan. State Government Pig Breeding Farms continued to maintain exotic breeds of pigs for distribution to farmers.

ANNUAL PLAN (1991-92)

A Centrally sponsored scheme "Assistance to States for Integrated Piggery Development" by Ministry of Agriculture, Department of Animal Husbandry was started during 1991-92 with a objective to establish new pig breeding farm and to strengthen existing pig breeding farms with a view to produce more number of exotic pigs for distribution to farmers.

EIGHTH FIVE YEAR PLAN (1992-1997)

During 8th Plan period Rs. 851 Lakhs was released for piggery development under scheme "Assistance to States for Integrated Piggery Development".

NINTH FIVE YEAR PLAN (1997-2002)

Ministry of Agriculture, Department of Animal Husbandry & Dairying is continuing a centrally sponsored scheme "Assistance to States for Integrated Piggery Development". Under this scheme a provision of Rs.20.00 crores has been allocated for IX Plan. An amount of Rs. 400 lakhs was released to strengthen 34 pig breeding farms during 1997-98, while Rs. 400 Lakhs was released to 38 pig breeding farms during 1998-99. An amount of Rs. 250 Lakhs were released during 1999-2000 to assist 13 New Pig Breeding farms at 10 Krishi Vigyan Kendra, one Veterinary College, Jabalpur and 2 State Government Pig Breeding Farms. A provision of Rs.300 Lakhs has been made for piggery development during 2000-2001.

The All India Coordinated Research Project on Pigs (AICRP on Pigs) has made significant contribution in research on breeding, nutrition and managerial aspects. During Ninth Five Year Plan one new centre at Ranchi (Bihar) has been opened. The Head Quarter is at Indian Veterinary Research Institute, Izatnagar with centres at Jabalpur, Khanapada, Tirupati, Kattupakkam, Mannuthy and Ranchi. The total outlay of this project during IX Plan amounts to Rs. 874.10 Lakhs.

6. PIGGERY IN NORTH-EASTERN STATES

The North-Eastern region, a vital entity of great Indian land has been in the limelight in spite of being geographically in the extreme corner of the country. By virtue of being pork as a major source of animal protein, the region acquired special importance in India. Pig Breeding Farms in North-Eastern Region represents 44.31% of total Pig Breeding Farms in India. The Pig Breeding Farms in North-Eastern Region are highest i.e. 11 in Meghalaya, followed by 10 in Arunachal Pradesh, 10 in Mizoram, 9 in Nagaland, 8 in Manipur, 8 in Tripura, 7 in Assam and 7 in Sikkim.

6.1 Pig population in North-Eastern States

The annual growth rate of exotic and cross-bred pigs is estimated (Indian Livestock Census 1987 and 1992) at 30.17% in Assam, 24.57% in Tripura, 13.07% in Nagaland, 12.23% in Mizoram and 8.45% in Sikkim in spite of highest pork consumption in these states. The detailed pig population in North-Eastern region is shown in Table 6.1.1.

Constraints of Piggery Development in North-Eastern Region

In spite of large number of farms, the exotic boar numbers at Pig Breeding Farms are not sufficient to cater the need of farmers and private pig breeding farms and co-operative societies.

It is well recognized that the reproductive performance of females is often a major limiting factor in pig production systems. There is a significant difference between the reproductive potential of sows and the reproductive achievement at farm level. Allowing 114 days for pregnancy, 21 days for lactation and 3 days for weaning to re-mating interval, the sow has the potential to produce 2.6 litters per year, but achievement of this target is extremely rare. In developed countries, 20 pigs per sow/ year is possible and is being achieved, while in India, the Government Pig Breeding Farms are hardly producing 10 pigs per sow/ year.

The major problem facing small-holder pig farmers in North-eastern States is that they have poor access to the genetic

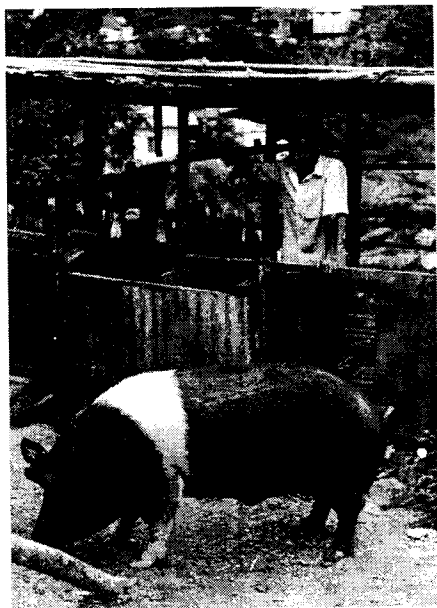


Fig. 6.2.1 Piggery Development in NE Region

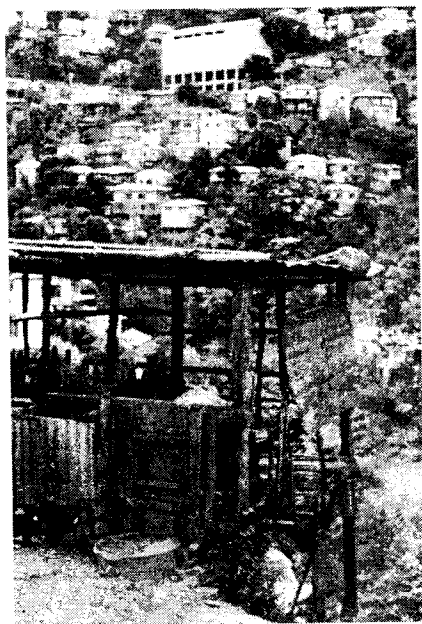


Fig. 6.2.2 A backyard Pig House of Mizoram

Table 6.1.1 Pig Population in North-Eastern Region(In 000)

State	Cross-bred pigs during 1987	Cross-bred pigs during 1992	Indigenous pigs during 1987	Indigenous pigs during 1992	Total Pigs during 1987	Total Pigs during 1992
Arunachal Pradesh	8	7	235	230	243	237
Assam	88	299	561	1065	641	1364
Manipur	133	132	250	251	383	383
Meghalaya	NA	102	NA	193	280	295
Mizoram	41	73	41	39	82	112
Nagaland	132	244	182	282	314	526
Sikkim	6	8	25	36	31	44
Tripura	4	12	84	176	88	188
Total All India					10626	12788

Source: All India Livestock Census 1987 and 1992.

resources needed for upgradation, multiplication and extension of pig farming.

The problems they face are largely due to the socio-economic and technical infrastructure. All the families, which are maintaining small units, cannot afford to maintain boar for breeding and they have to pay Rs. 400-500 for one conception to the private breeder.

6.2 Piggery Development in North-Eastern States

The pig has a special attraction and significance in the north eastern region and on average a pig is being reared by a family in this area. As per the Indian Livestock Census, 1992 the Assam has the highest population of pigs, i.e. 1364,000, followed by Manipur (383,000), Meghalaya (295,000), Arunachal Pradesh (237,000), Tripura (188,000), Mizoram (112,000) and Sikkim (44,000). Assam alone has recorded 10.66% of pigs of India, as per 1992 census. The rate of growth in 1992 over 1987, was highest in Tripura (113.64%), followed by Assam (112.79%), Sikkim (41.94%), Mizoram (36.59%) and Meghalaya (5%).

During VIII Plan Government of India had provided Rs. 606.71 lakhs as Grant-in-aid under scheme "**Assistance to States-for Integrated Piggery Development**" for strengthening of Pig Breeding Farms in North-eastern states, which is 48.49% of the total grant-in-aid released for piggery development. During 1991-92 Government of India had sanctioned Rs.3.00 lakhs to Arunachal Pradesh, Rs.3.00 Lakhs to Assam, Rs. 3.00 Lakhs to Mizoram, and Rs. 3.00 lakhs to Sikkim, which amounts to 34% of the total grant of India, i.e. Rs.35.00 lakhs.

6.3 National Commission on Agriculture (1976)

During 1976, a commission appointed by Government of India, analyzed the performance of pig farming and a report was released.

6.3.1 Comments of National Commission on Agriculture

32.1.29 Pig development has a special significance in the north eastern hilly regions. Pork and Pork Products are popular in the north eastern States. Consumption of pork is very high. We are very pleased to learn that the Central Government is taking up a very comprehensive piggery development programme for the north eastern States with the help of

Danish International Development Agency. As has been envisaged under this programme, a regional pig breeding station of 200 sows capacity will be established at Shillong and there will be 7 sub-units for all other north eastern states and one sub-unit for Assam Agricultural University. Each of the sub-units will have 30 breedable sows. A pig slaughter house having capacity of handling 20 pigs a day will be attached to the Regional Pig Breeding Station. A pig Slaughter house having the capacity of handling 10 pigs a day will be attached to each of the sub-units.

32.1.30 We are of the view that the Central Government have taken up a right decision for intensifying pig production in the north- eastern states. Intensification of pig production will be timely action to bring about a balance between supply and demand for pork. The scheme should be implemented expeditiously.

6.3.2 Summary of NCA Recommendations

7. Immediate steps should be taken to remove the constraints standing in the way of undertaking suitable pig breeding programmes in the Regional Pig Breeding Stations and the Pig Breeding Farms/ Units near the bacon factories.
11. The nucleus breeding herd in the Regional Pig Breeding Stations should be strengthened.
12. Considerably more exotic pigs are required to be imported for undertaking selective breeding programme on scientific lines in Regional Station.
14. For some of the north-eastern states breeds like Berkshire, Hampshire, Saddleback or Poland China should be selected for breeding as the people in these areas prefer black coloured pigs.
17. A co-ordinating cell should be created for proper execution of the Co-ordinated Pig Breeding Programme.
19. Agricultural Universities should undertake studies on pig breeding with indigenous and exotic breeds of pigs.
20. The programme for pig development in the north-eastern states should be implemented soon.

6.4 All India Co-ordinated Research Project on Pigs

The Indian Council of Agricultural Research (ICAR) initiated an All India Co-ordinated Research Project on Pigs during the Fourth Five Year Plan. The Project sanctioned in October, 1970 started functioning early in 1971. The major

objective of the project is to develop suitable breed or breeds using imported stock. Out of the 7 centres, one is functioning in North-eastern states, i.e. at Assam Agricultural University, Khanapada, Assam.

Government of India had also released Rs. 16.77 Lakhs during 1996-97 to Assam Agricultural University, Khanapada for establishment of Pig Breeding Farm in Assam.

6.5 Cultural Habits and Piggery in NEH Region

6.5.1. Arunachal Pradesh

Arunachal Pradesh stretches from the ridge of eastern Himalaya to the foothills bordering the Brahmaputra River. It shares a border of more than 800 km with China. It also borders Bhutan and Myanmar. It is one of the most sparsely populated states of India. There are 5 major rivers i.e. Kameng, Subansiri, Siang (later the Brahmaputra in Assam), Lohit and Tirap and the mountain range follow the river systems.

Peoples and Culture

The population is very scattered and sparsely, i.e. 10 persons/sq. km. There are 20 major tribal groups which is of very diverse origin. Each tribal group possess very district cultures, with a variety of dance, music and folk traditions.

History

Arunachal Pradesh finds mention in the literature such as the Kalika Purana and in the epics of Mahabhartta and Ramayana. It is believed that sage Vyasa meditated here and also that the remains of the brick structure, scattered around two villages in the hills north of Roing was the palace of Rukmini, the consort of Lord Krishna. The sixth Dalai Lama was also born on the soil of Arunachal Pradesh. The Tawang monastery, the largest of India, dates from the 1600's, which is a 10 km drive from Bomdila. This monastery dominates the valley with a grand view of the Himalayas. A 8 meter high gilded statue of the Buddha is located here. The tall central monastery, known as Tawang Gompa.

Land and Climate

The state has a variety of terrain, stretching from the snow-

capped mountains of the Himalaya, some of which are 6000 meters high, to the steamy plains of the Brahmaputra valley.

The high mountain ranges in the north are permanently under snow. At the edge of the plains, average minimum temperatures range from 8°C in January, and 19°C for the summer months. The average maximum temperature range from 15°C in January to 25°C in May and August. The annual rainfall is more than 260 cm and mostly between May and October.

Wild Life

The wildlife includes clouded leopard, elephant, Himalayan black bear, musk deer, red panda, sloth, snow leopard and tiger. One zoo on the banks of the Bharali river at an elevation of 190 meters is located at Tipi.

Pig Population and Pig Breeding Farms

As per Indian Livestock census, 1992, the pig population is 237000 pigs. There are 10 pig breeding farms in the states and breeds of Large white Yorkshire and Hampshire are being maintained at Government Pig Breeding Farm at Karsingsa, Loiliang and other farms. The cross-bred pig population during 1992 was 7000 pigs, which is very low and there is need to introduce more number of exotic pigs.

6.5.2 Assam

Assam is the gateway to the North-East, located between 90°-96° East Longitude and 24-38° North Latitude. Assam is dominated by the mighty Brahmaputra river that has its origins in Tibet. A large part of the state is located in the narrow valley. It has international borders to the north with Bhutan and to the southwest with Bangladesh. Assam shares border with four hill states, i.e. Nagaland, Manipur, Mizoram and Tripura.

People

Assam is the largest and highest populated state in the region. Most people are descendants of Mongolid tribes from the east. The main language is Assamese and Bengali is also spoken. The state's population includes a starling mix of Dravidians and Aryans and Tibeto-Burmans.

Land and People

The Brahmaputra Valley has fertile alluvial soil. Rice is the main crop. Bananas, beans, gram, oranges, peas and pineapple are also grown. World's 12% tea and about 50% of India's tea is grown in Assam. The jute, oilseeds and sugar cane is also grown in the region. Bamboo is used in paper making, handicraft industry, weaving and pottery making.

Wildlife

Kaziranga, is one of the most visited wildlife reserves of India and is famous for one horned rhinoceros. The present rhinoceros population is more than 1100. The park also has bison, elephant, hog deer, hoolock gibbon, sambar, swamp deer, tiger, wild buffalo and wild pig. There are otters and gharial in the rivers.

Land and Climate

Assam receives average rainfall between 180 cm and 250 centimeters mostly between monsoon season of June to October. The average minimum temperature is about 10° in January, while maximum temperature is 32°C in April and June to August.

History and Culture

The ancient kingdom of Kamarupa "*Pragiyaisha*" was located near Guwahati. Kamarupa is mentioned as a frontier kingdom and tributary of the Gupta Empire in the Allahabad inscription of Samudra Gupta (A.D. 330-375).

The Kamakhya temple, a top Nilachal hill, is a famous temple of Goddess Kamakhya.

Pig Population and Pig Breeding Farms

As per Indian Livestock census, 1992, the pig population is 1364000 pigs, which recorded the 112.79% growth rate from 1987 census. There are 7 pig breeding farms in the states and breeds of Largewhite Yorkshire, Saddleback, Large Black and Hampshire are being maintained at Government Pig Breeding Farm at Khanapada, Diphu, Haflong, Kaliapani, Khanikar and Marigaon. The cross-bred pig population was 299000 pig during 1992.



Fig.6.5.3.1 Pig Rearing in Manipur



Fig. 6.5.3.2 A close-up of Manipuri Pig

6.5.3 Manipur

Manipur lies south of Nagaland and north of Mizoram and shares an international boundary with Burma.

Land and People

Most of the Manipur peoples are tribal farmers with a mixture of Burmese and Mongolian influences. Most of the population in the valleys are Hindu. They worship god Vishnu.

Culture and People

Manipur is famous for Manipuri dance, which is a classical dance form marked by graceful and restrained movements and delicate hand gestures. A legend is that the discovery of Manipur was the result of the delight that gods took in dancing.

Manipuris are recognized as skillful warriors and still practice the arts of wrestling, sword fighting and martial arts. Manipuri polo known as “Sogol kangiei” is the principal sport of the state, and it is believed that the polo was originated from Manipur. The language is Manipuri.

Wildlife

Manipur is having forests in which bamboo and teak are common but magnolia and oak are also widely spread. Blue poppies, primroses and rhododendrons are common flowers. The wildlife includes elephants, rhinoceroses and tigers.

The Zoological garden at Iroishemba, 6 km away from Imphal Kangchup road is a shelter of the world- the brow antlered deer.

The Sendra Island and Loktak lake, which is located at 48 kms away from Imphal, saucer shaped fresh water lake that attracts many species of birds. It is formation of rare ecosystem in which huge and beautiful stretch of water is like a miniature island sea and island of Loktak float comprising of marsh and grass and root of solid earth. The “Keibul Lamjao National Park”, which is situated on the fringes of the Loktak lake is the only floating National Park in the World. It is also a habitat of the endangered dancing deer, brow antlered deer of Manipur.

Climate

Winter temperature at Imphal fall to a minimum of 4°C at

night and day temperature rises to 21°C. The average summer temperature is 29°C mostly from April to September. The annual rainfall at Imphal is about 40 centimeters.

Piggery Development

There are 8 Pig Breeding Farms in Manipur maintaining Large White Yorkshire, Landrace and Hampshire pigs. The cross-bred pig population during 1992 was 132000 m which was a good proportion as compared to indigenous pigs i.e. 251000 pigs.

6.5.4 Meghalaya

Meghalaya is a small state sandwiched between Assam and Bangladesh having an area of 22429 sq. km and is located between 25° and 26.15° Latitude and 89.45° and 92.47 Longitude.

People and Culture

The people of Meghalaya mainly comprise of three tribes, the Khasis, the Jaintias, and Garos, who are also found in Bangladesh. Each group has its own tribal language. The Garos came originally from Tibet. The Khasis are probably Austro-Asiatic and the Jaintias are Mongolian and similar to the Shans of Burma. The Jaintias believe in the universal presence of God, and they have not built temples. They commemorate the dead by erecting monoliths, and groups of large stones can be seen in villages in Central Meghalaya.

The predominant role of women is highly visible in Khasi hills, where the Khasis, follow a matrilineal society. Under this custom, the children take the name of their mother and the youngest daughter becomes the custodian of family property.

The tribal people still practice shifting agriculture. They grow ginger, oranges, pineapples and potatoes as cash crops and rice, maize and vegetables as food crops.

Land and Climate

Meghalaya means “abode of the clouds”. The south facing slopes overlooking Bangladesh have had more rainfall in one year than any other place in the world.

The average minimum temperature in summer rises to 15°C

and maximum average temperature rise to 23°C. In winter, the average minimum temperature rise to 4°C and average maximum temperature is 16°C. The annual rainfall is more than 200 centimeters in Shillong between June and September. Cherrapunji has been known to have 2500 centimeters of rain in one year.

Wild life

Pine, sal and bamboo forests dominate the natural vegetation. Wildlife includes elephants, leopards, tigers, oxen, wild pigs, apes, monkeys and squirrels. The forests have many colourful birds such as parrots and partridges.

Piggery Development

There are 11 Government Pig Breeding Farms in Meghalaya which are maintaining Large White Yorkshire, Landrace and Hampshire pigs. The cross-bred pig population during 1992 was 102000 pigs as compared to indigenous pigs i.e. 193000, which was a good proportion. The total pig population was 295000 during 1992. There is a very good scope for piggery development in Meghalaya.

6.5.5 Mizoram

It is situated towards the southernmost tip of the North-Eastern states, sharing borders with Manipur, Assam, Tripura then jutting down between Myanmar and Bangladesh.

The word “Mizo” means highlander, a name given by the neighbors of a number of tribes, which settled in the area in the 1700’S. Most Mizos are Christians, and the remainder mainly nomadic Chakmas along the western border are Buddhists who have a tradition taking in elements of Hinduism and animism.

Lard and People

The state has a population density of only 23 people per square kilometer. Most of the people are subsistence farmers, growing only enough maize and rice for their needs. Many people follow a nomadic “slash-and-burn” method of shifting cultivation called jhum. Plantation crops such as coffee, rubber and tea is also grown.

Many people are employed making handwoven textiles and

other handmade objects of bamboo. Bamboo is a raw material for a range of goods, such as making ceremonial hats known as khumbou.

Land and Climate

The state capital of Aizawl is located at an altitude of 4000 feet above sea level, standing on a high ridge surrounded on the east by the deep green valley of river Tlawng, with its lush green deep valleys, and on the north protected by beautiful high craggy hills of Durtland.

In summer the average maximum temperature is about 29°C and average minimum temperature is about 20°C. In winter the maximum temperature is 21°C and average minimum temperature is 11°C. The state receives a heavy rainfall of about 300 centimeters, mostly in May to September.

Wildlife

Dampa Sanctuary, which was established in 1976, is inhabited by swamp deer, tiger, leopard, elephant, hoolock gibbon.

Other wild animals includes hog deer and wild pig live in the forests.

Mizoram Pig Industry

The third youngest state of the Union- Mizoram, perching on the high hills of North-Eastern Corner is flanked by Bangladesh on the West and Burma on the East and South. It has an area of 21,087 sq. km. The population of the Mizoram is 689756 persons, with 87.48% literacy rate surpassed only by Kerala. Most of the Mizos are Christians. The density of population is 33 persons/ sq. km. It has 3 districts, i.e. Aizawl, Lunglei and Chhimtuipui.

As per the Indian Livestock Census, 1992, the pig population of Mizoram was 112000 pigs, which was 26.79% higher than that of pig population during Indian Livestock Census, 1982 (82.000 pigs). The density of pig population is 5.31 pigs/sq. km., which is higher even after consumption of pork throughout the year, as most of the Mizos are Christians. There are 10 Pig Breeding Farms in Mizoram, 9 farms under

the control of Government of Mizoram, and one farm which was under the control of Govt. of Mizoram, has been transferred to Central Agricultural University. Most of the pigs reared by the Mizos are cross-bred pigs consisting of crosses of Large White Yorkshire, Hampshire etc.

The private farms consists of one to 2 sow units to 50-60 sow units, and every family is rearing at least one sow unit.

The boars are kept by the private pig breeder, and whenever sow is in heat the boar is taken to the sow after paying Rs. 400-500 depending upon the distance and location.

Scope of Introduction of AI in Mizoram

In view of the great improvement in recent years in the controlled breeding of pigs, there is the obvious possibility of pig improvement through reproduction and artificial insemination.

In Mizoram, a sow produce an average of 1.8 litter per year with 7.2 pigs from each litter reaching market weight. Their is a potential for improvement of productive performance by management of ovulation, fertilization and maintenance of pregnancy and effective diagnosis of pregnancy. If an average sow can produce two litters per year with 10 pigs marketed per litter, we can boost up pig production in Mizoram. There is an urgent need to increase the reproductive efficiency of pigs, which can be significantly increased by the use of artificial insemination in pigs.

Economics of AI

The cost of Golden pig catheter, Cochette beg and diluted semen of two doses amounts to Rs. 100/ conception, which would be lower than the cost presently paid to the private breeder @Rs. 400-500.

Artificial Insemination in Pigs

Artificial insemination (AI) is the deposition of spermatozoa in the female genital tract by artificial instruments rather than natural service. It enables the use of superior boar to 10 times more number of sows. The cost of artificial insemination is lower than that of natural service.

Advantages of AI

- 1 Very large number of offsprings can be produced from elite boar with the help of AI.
- 2 Some sexually transmitted diseases can be prevented by use of AI.
3. Boar produce large volumes of gel from the bulbo-urethral (Cowper's) glands in addition to large volumes of gel free semen 150-300 ml. After collection and evaluation of the semen for sperm density and motility, ejaculates can be extended 2 to 4 times. A 50 ml volume of diluted semen with 5000 million spermatozoa is necessary to inseminate a sow. At least two inseminations during oestrus are recommended for sows. A boar ejaculate can be successfully used to inseminate 10 females.
- 4 The conception rate and litter size in pigs artificially inseminated at 36 hrs after oestrus gives highest litter size and insemination just after ovulation gives maximum conception rate(%). For getting the maximum effect of both litter size and conception rate two inseminations are necessary.
- 5 There is no longer necessary to maintain costly boar on all the breeding farm and on private farms.
- 6 Possible to reduce the number of boars needed for pig Breeding farm.
- 7 Reduction in cost of breeding and management.
- 8 Maximum use of superior boar to large number of sows.
- 9 No need to maintain boars at farmers level.
10. Takes less time and energy.
11. Systematic Monitoring of Semen
12. Enables breeders to benefit from the advances in genetic selection.
13. Uniform Pork Production with better carcasses.
14. Increased number of piglets.
15. Reduction in diseases.

AI Training cum Demonstration Workshop in Mizoram

IMV, company demonstrated the technique of collection of semen by using the dummy made from the locally available

material like gunny bag, straw, wooden and iron support etc. For collection of semen no artificial vagina is required. The semen was collected by hand with gloves, and was collected in collection bottle.

Evaluation of semen

After collection the semen was evaluated for the motility for working out the quality of semen. The motility was examined under the compound microscope already available at the farm or laboratory of Aizawl.

The concentration of the spermatozoa was calculated by placing the semen in photometer, and it took only 1 minute.

Dilution of the semen

The semen was diluted by using 1 litre ready to use diluter (IMV, France). The diluter was in powder form and was dissolved in one litre of distilled water. The semen was gently added to the diluter (with same temperature) for making doses as per the no. of spermatozoa available in the semen. It works out approximately 10 doses per ejaculation.

Packing of the semen

About 90 ml of the semen was packed in Cochette bag supplied by the IMV and sealed by Manual Model of filling machine which fills the cochettes by gravity. The output of this manual model is 150 doses/ hour, which can be upgraded to semi-automatic status by the addition of the IMV peristaltic pump.

A special device on the machine for pre-opening the sachet radically reduces contamination thus ensuring optimal hygiene and minimizing disease risks. The Cochettes are supplied in rolls of 500 or 1000 airtight sachets.

I had also tried the filling and sealing of the semen myself and it was very easy.

Storage of the Semen

The semen was stored at 18° C only. The shelf-life of the diluted semen was one week.

AI in Gilts

The heat was detected in gilts and the technique of AI is

very simple. There is no need for any insemination crate, as the gilt or sow in heat would not move after putting back pressure. The golden catheter is inserted inside the cervix through vulva.

After fixing at proper place the Cochette bag filled with semen was attached to catheter. The gilt sucked the semen automatically within 2-3 minutes.

The Goldenpig catheter has dual function, being used for both vaginal and uterine veterinary treatments and as well as AI. It is designed to be particularly sow-friendly, with a soft, spongy tip and a shape that does not allow to do injury in the urinary tract, thus avoiding damage, bleeding or irritation to the sow. It is hygienic as it is disposable and reduces the risk of disease transmission.

Results of Success of AI in Pigs

The conception rate(%) and litter size (no. of piglets born at one time of farrowing) and other results are very encouraging and this technique can be used for introduction to other parts of the India.

Imported Exotic Pigs maintained at Regional Pig Breeding Farm, Selesih

Government of Mizoram imported 89 Large White Yorkshire young male and female consisting of 19 males and 70 females. Out of which one male and 2 female died and at present 18 boars and 68 gilts are being maintained and are healthy. For introduction of Artificial Insemination in Pigs, the selection for collection of semen was made from these boars and gilts from this group only selected for insemination.

Mating Plan for Imported Exotic Stock

The Mating plan in respect of imported pigs has been approved by the Government of Mizoram.

The existing Piggery farm at Selesih will act as base farm where planned mating of the foundation stock will be carried out as judiciously as possible to maintain the stock true to breed as well as to prevent inbreeding. Improvement of the breed will be attempted through selection in this farm. The F_1 progenies from the foundation stock will be distributed to the other

departmental piggery farms. These farms will act as multiplication Farm where cross breeding will be carried out for the production of commercial piglets, as well as production of pure breed boar for breeding purpose. Few progressive farmers with adequate resource from potential village will be selected to keep the purebred breeding boar from multiplication farm on contract basis for crossing local pigs in field condition. The management and health care of the field breeding boar would be closely monitored by the Department.

1. The foundation stock are distributed into 9 groups consisting of 2 males and 8 females in each group, whereas 2 groups will have 7 and 6 females respectively.
2. The F_1 progenies will be distributed to other departmental farms.

Visit to the Private Breeding Farms of Aizawl

I had visited some of the private breeding farms and small units of pigs of Aizawl, and found piggery as one of the very profitable animal husbandry activity in Mizoram.

One Profit Making Private Pig Breeding Farm

One of the Private Pig Breeding Farm owned by Mr. C. Lalran Mawitea, at Dinthar II, V Sector, Aizawl (Ph. 27279) was visited by me along with the Officer of the Department. I was told that recently he has disposed most of the stock. At the time of visit, he was having 2 breeding boars, 2 young boar, 2 sows/gilt and 6 young piglets. He sold piglets @ Rs. 1500/- per piglet during 1997-98. He is charging Rs. 400 to 500/ service from the farmers. He is maintaining service record of individual boar. One boar performed 170 services between 20th Feb 95 to 19th Feb 1996. If for calculation we take Rs. 400/service, the income from one boar in a year amounts to Rs. 68,000/-. He used to feed rice polish, dalia, and 1 egg/day to the breeding boar. The boar houses were made of wood and galvanized tin shade and cost of construction of one boar house amounts to Rs. 2000/-. His average monthly income amounts to Rs. 10,000/ from this business. I was given to understand that he had purchased Colour Television, Fridge, House, Gas, Telephone

and other modern living appliances from the income of the pig business. But he expressed his main problem about non availability of quality pigs.

6.5.6 Nagaland

Nagaland, a narrow strip of mountain territory, lies east of Assam and west of Burma. This is predominantly tribal state and is the only state which has English as official language.

Land

Nagaland is bordered on its south, west and north by the states of Manipur, Assam and Arunachal Pradesh and it shares an international border with Burma to its east.

Climate

It has a pleasant temperate climate, but has a very heavy rainfall in summer months. Winter temperature ranges from an average minimum of 8°C to an average maximum of 15°C in January. The average minimum temperature in summer is 19°C, while average maximum temperature rise to 25°C in May and August. The average rainfall during summer is over 180 centimeters in Kohima.

People and culture

The population of Nagaland consists of several groups of tribes that originated in Tibet and Burma. More than 90% population is Christian and rest are Muslims and Hindus. The main languages are Nagamese and English. Their villages on hilltops and ridges and are protected by stone walls. The main building in a village a “morung”, a long house of about 20 meter long and 10 meter high. By each morung stood a huge, sacred drum, which the Nagas hollowed out of a tree trunk and carved to resemble a buffalo head. The history of their culture is shown in wooden images, masks, jewellery and headgear.

Economy

The shifting cultivation i.e. “slash-and-burn” techniques of jhum is still being practiced in some villages, but the period between successive cultivations has diminished to a couple of years from 10 to 15 years. The main crops are rice and maize, however, millet, oil seeds, potatoes, pulses and sugar cane are

also grown. Bamboo is a valuable major forest product and they produce many artistic and functional items by traditional handicrafts. Women in Nagaland practice the ancient craft of weaving on portable hand looms. They stitch together strips of colorful cloth to produce shawls in different patterns which distinguish each tribe. The shawl is a universal garment worn by Nagas all over the state.

Wildlife

Nagaland is proud of its rich wildlife including the flying lemur, the long-tailed langur, pink-faced monkey, elephants, porcupines, rhinoceroses, scaly ant eaters, tigers, Hoolock gibbon and wild oxen. There are also many colorful jungle birds such as tragopan pheasant etc.

Piggery Development

There are 9 Government Pig Breeding farms in Nagaland. The exotic pig population during 1992 was 244000 as against indigenous pigs i.e. 282000. During 1999-2000, Government of India, Ministry of Agriculture had given assistance for establishment of 2 new Pig Breeding Farms in Nagaland.

6.5.7 Sikkim

Sikkim is the second smallest state in India and lies in the eastern Himalaya and contains "Kanchenjunga", the highest mountain peak in India and third highest mountain in the world. Forest cover one-third of the state and have enormous potential

Land

Sikkim lies in the eastern Himalaya between Nepal, to the west, and Bhutan, to the east. To the north are Tibet and China and West Bengal to the south. The state contains the upper valley of the Tista River, a tributary of the Brahmaputra.

Climate

In lower valley, the climate is subtropical and above 1000 meters, the climate is temperate. The tops of the higher mountains are permanently under snow. In Gangtok, at an altitude of 1500 meters, the average minimum temperature is 4°C and the average maximum temperature rise to 14°C during winter months. During summer, from April to October, the

maximum temperature rise to 22°C while minimum temperature rise to 14°C. The area receives annual rainfall of about 350 centimeters.

People and Culture

The original inhabitants of the region are the Lepchas, now from the minority of the population, along with the Bhutia from Tibet. Their main religion is Lamaistic buddhism. The rest of the population are mainly Hindu immigrants from Nepal.

Economy

Farming is the main activity and they grow maize, rice, barley and wheat. Large cardamon, ginger, oranges, potatoes and tea are grown in the foothills.

Wild life

There are more than 500 species of animals and birds, including yaks, bears, red pandas, silver foxes and leopards.

Piggery Development

There are 7 pig breeding farms in Sikkim. The exotic pig population during 1992 was 8000 pigs as compared to pig population of indigenous pigs, i.e. 36000, which is very low. There is an urgent need to introduce more number of exotic pigs in Sikkim.

6.5.8 Tripura

Tripura is a hill state in north-eastern region. It is surrounded on the north, west, south and south-east by the international boundary of Bangladesh. In the east it has a common boundary with Assam and Mizoram. About 60% of the area of Tripura is under hills and forests. It has an area of 10491.69 sq. km.

History

The name Tripura appears on pillars of the emperor Ashoka, who ruled India in the 200's B.C.

People and culture

Tripura represents a composite culture with several ethnic groups and termed as "laboratory" of exotic cultural synthesis. It is inhabited by 19 tribes, Bengali, Manipuri and other communities.

Climate

The average maximum temperature in summer rise to 37.1°C, while average minimum temperature rise to 16.9°C. During winter, the average maximum temperature rise to 28.7°C and average minimum temperature rise to 5.3°C. During monsoon season, June to September, Tripura receives more than 219.9 centimeters.

Economy

Rice is the main food crop, and jute and tea are cash crops. Cotton, fruit, mesta, mustard, potatoes and sugar cane are also grown. Basket making, carpentry, pottery and weaving are common activities of people.

Wildlife

Tripura has many wild animals including elephants, tigers, wild boar, wild buffalo, and the world's largest ox, the gaur. Sepahijala Wildlife Sanctuary, is about 25 km from Agartala covering an area of about 18.53 sq. km. About 150 species of birds and the unique spectacled monkey are the attraction of this sanctuary. The Trisna Wildlife Sanctuary is located about 100 kms. away from Agartala. The bison is the main attraction of this sanctuary apart from some resident and migratory birds.

Piggery Development

In Tripura, the local pig is of wild type and has poor litter size and meat yield. Due to the poor production of local pigs, exotic breeds of pigs such as Large White Yorkshire, Hampshire has been adopted in this area. As per 1997 census, the pig population of crossbred and exotic pigs comprise of 39085 pigs and indigenous pigs 197812 pigs making a total population of 236897 pigs. The percentage of growth rate of pigs from 1992 to 1997 is recorded 26.06%.. There are 8 Government Pig Breeding farms in Tripura and the total number of piggery units in private sector are more than 611. As per 1997 census, the per capita meat availability is 1.192 kg.

7. AVAILABILITY OF PIGS IN INDIA

Exotic breeds of pigs are being maintained at various farms managed by State Governments, Livestock Development Corporations, International Pig Breeding companies, Private pig breeding farms, Piggery Co-operative societies, and Piggery Federations.

7.1 Pigs at Government Pig Breeding Farms

Different breeds of Exotic pigs like Large White Yorkshire, Hampshire, Middle White Yorkshire, Landrace, Saddleback, Berkshire, Tamworth, Duroc etc. are being maintained at 158 Government Pig Breeding Farms located in India. These farms are being assisted by Government of India, Ministry of Agriculture, Department of Animal Husbandry & Dairying under a centrally sponsored scheme "Assistance to States for Integrated Piggery Development". Under this scheme these farms are given 100% grant in aid for Import of exotic pigs, construction of sheds, land development, purchase of equipments and training assistance for training of farmers in pig farming.

These pig breeding farms not only provides piglets to farmers at nominal price but also impart training in pig farming on modern lines. They also advice the farmers for control of diseases of pigs.

7.2 Pigs at Livestock Development Corporations

Some pig Breeding farms are functioning under Livestock Development Corporation for providing piglets to the farmers at reasonable price and for imparting training in pig farming. These Farms are breeding pigs for distribution to the farmers and for interfarm purchase.

7.3 International Piggery Projects

There are large number of International pig farms, which are supplying quality purebred stock to different countries. They also supply quality hybrid pig stock for fattening.

7.4 Role of Private Piggery Farms

There are some private Piggery farms, they are of two types, one type is involved in only breeding and distribution to the farmers, and other type only engaged in fattening for supply to

bacon factories and pork processing plants.

7.5 Piggery Co-operative Societies

Piggery is an important activity increasing amongst piggery cooperative societies. It is highly profitable activity and can be easily managed by forming co-operative societies. Piggery is also popular amongst women piggery co-operative societies specially in North-Eastern States. Some women piggery units/beneficiaries have come up in Manipur under assistance from STEP scheme of Ministry of Human Resources Development, Department of Women and Child Development.

7.6 Piggery Federations

Piggery federations are active mostly in North-Eastern Region and they are involved in breeding and distribution of piglets to their members and beneficiaries.

8. IMPORT OF PIGS

8.1 Indigenous Breeds and their Performance

In India, we have only three breeds of indigenous pigs, i.e. Andaman and Nicobar Pigs, Ankamaly Pigs and Deshi pigs. The production potential of these indigenous breed is however very low as compared to exotic pigs.

The performance of some superior exotic breeds and desi pigs are as follows:-

	Performance of	
	Desi Pigs	Exotic breed
Litter size at birth	7.52	10.44
Birth weight (kg)	0.91	1.40
Weaning weight (kg at 56 days)	4.15	13.57
Weaning percentage	54	78.5

It is obvious from the data given above that to improve the production performance of desi stock to anywhere near that of exotic ones without introducing any exotic inheritance would be an impossible task within a limited period of time and reasonable investment. This is so because the heritability of reproductive traits is not high and those for the traits like body weight gain and feed conversion efficiency is only moderate.

8.2 Why import of Pigs?

1. The production potential of indigenous pig is very low. However, Exotic pigs of Large White Yorkshire, Landrace, Hampshire etc. and cross-bred pigs are being maintained at 158 Government Pig Breeding farms of the country, but due to inbreeding they do not have quality pigs.
2. The research done by All India Co-ordinated Research Project on Pigs (ICAR) on their exotic pigs as compared to the pigs selected for import are as follows:

Performance Parameter	Large white Jabalpur	Yorkshire Tirupati	Landrace Izatnagar	Khanapara
a) Litter size	8.96	8.38	8.31	8.16
b) Average Wt. at birth(kg)				
Male	1.28	1.28	1.37	1.27
Female	1.25	1.25	1.35	1.23
c) Litter size at weaning	8.26	7.96	5.97	7.52
d) Wt. at weaning (kg)				
Male	11.62	11.31	11.47	11.10
Female	11.41	11.41	11.39	11.08
e) Av. wt at 32nd week(kg)				
Male	65.90	59.36	59.14	63.00
Female	70.11	60.33	55.17	61.98

The performance was significantly poor than their contemporaries in the country of their origin. Therefore, these pigs and their progeny is not suitable for breeding at Government Pig Breeding farms.

3. In India, we have good native breed of all the domestic animals except pigs. Therefore, there is a need to maintain exotic pigs and to upgrade local pigs by cross-breeding, for which good quality exotic pigs are required.
4. As per Indian Livestock Census, we have only 20% of cross-bred pigs, i.e. 1859000 pigs during 1992, which is very low.
5. National Commission on Agriculture (1976) stressed on Import of exotic pigs for development of piggery. They had also added that the policy of grading up the indigenous stock by using males of improved exotic stock is also sound and suitable under the prevailing conditions.

“32.1.22 A prerequisite for undertaking any selective breeding programme is the procurement of a good foundation stock. It is worthy of note that the Central Government have recently laid down certain selection criteria for importation of pigs for breeding purposes. Furthermore, for achieving success in developing high production stock, maintenance of a minimum effective breeding population is necessary. The nucleus breeding population size should be 200 sows and 20 boars to avoid inbreeding and to have reasonable degree of selection intensity. Many more exotic pedigreed pigs need to be imported for implementing selective breeding programmes on scientific lines in the Regional Pig Breeding Stations.”

6. No Government or Private Pig Breeding Farm is maintaining 200 sows and 20 boars to avoid inbreeding in the country, therefore there is a strong need to import large no. of pigs for pig breeding farms.
7. NCA (1976) also stressed to introduce the technique of Artificial Insemination in pigs, for which import of pigs is essential.
8. An All India Co-ordinated Research Project on Pigs (ICAR) was started in 1970, but the performance of their pigs is significantly lower than the exotic pigs of reputed breeds and they are not in a position to supply commercial pigs.

8.3 Comments of NCA

“Para 32.1.21 Pig population in the country consists mostly of indigenous non-descript types. The indigenous pigs are generally black or dark brown in colour and vary considerably in size and type. From available reports it appears that the indigenous pigs in general attain a body weight of 30-45 kg at 18 months of age. The preferred marketable body weight of 90-95 kg is attained by the improved exotic varieties of pigs in about 5-6 month period in countries with developed pig industry.”

8.4 Minimum Breeding Programme for Exotic Pigs

For achieving high production pig breeding stock, maintenance of a minimum effective breeding population of pigs is necessary. The nucleus breeding population size should be 200 sows and 20 boars to avoid inbreeding and to have reasonable degree of selection intensity. In India, no Government Pig Breeding Farm is maintaining this size. Therefore, many exotic pigs need to be imported for implementing selective pig breeding programmes on scientific lines in the Government Pig Breeding farms.

8.5 Import of Pigs by India

Prior to arranged imports by various State Government, following pigs were imported up to 1976 from USA, Australia and Ireland.

The Scheme was started in 1991-92, and 87 pigs were imported for Mizoram during 1997-98. The details of the major import of pigs is as follows:-

Import of pigs in India for Pig Breeding Farms of India is as follows:

Year	1977		1979		1989		2000	
Breed	Male	Female	Male	Female	Male	Female	Male	Female
L.W.Y.	52	112	44	108	62	137	54	72
Landrace	29	63	4	1	8	10	14	13
Hampshire	22	61	41	183	6	15	48	79
Saddleback			3	6	10	5		
Berkshire					5	4		
Total	103	236	92	298	91	171	116	164

8.6 Government of India Scheme for Import

A Centrally sponsored Scheme "*Assistance to States for Integrated Piggery Development*" was started during 1991-92 to assist State Government Pig Breeding Farm by way of 100% Grant-in-aid for development of infrastructural facilities like Improvement and strengthening of herd through purchase of exotic pigs and their transport cost; alteration and remodeling, renovation, additional housing for pigs, stores, office ; land development, leveling, fencing and watering facilities; and for purchase of equipment, feeding utensils and necessary furniture etc., with a total grant of Rs. 6.00 lakhs per farm. During 1995-96, the EFC memo was revised on 7th December, 1995 to include Pig Breeding Farms under 1. State Government, 2. Agricultural Universities/ Veterinary Colleges, 3. Krishi Vigyan Kendra under ICAR.

For Improvement & Strengthening of herd through import and transport cost an amount of Rs.6.00 lakhs per New Pig Breeding farm and Rs.14.00 Lakhs for existing pig breeding

farms under State Government, Agricultural University and Krishi Vigyan kendra under ICAR are given as 100% Grant-in-aid.

8.7 Procedure for Import of Pigs

Pigs can be imported under Export and Import Policy formulated by the Directorate General of Foreign Trade, Ministry of Commerce, Government of India, which is effective from 1st April, 1997 to 31st March 2002 and Foreign Trade (Regulation) Rules, 1993.

Import of Pigs is included in the negative list of import for which license is necessary.

Application for Grant of License

An application for grant of license for import of pigs may be made in the form given in Appendix-8 to the Director General of Foreign Trade along with the recommendation of the Department of Animal Husbandry and Dairying, Government of India, Krishi Bhawan New Delhi.

Fee for License for import of Pigs

Every application for a license to import pigs shall be accompanied by the fee specified in the Schedule i.e. Rs. 200/- if the value of pigs specified in application does not exceed Rs.50,000 ; Rs.2/1000 or part thereof subject to a minimum of Rs.200/- if the value of the pigs specified in the application exceeds Rs.50000 but does not exceed Rs. 10000000.

No fee shall be payable in respect of any application made by the Central Government, a State Government or any department or any office of the Government.

Conditions of License

It shall be deemed to be a condition of every license that the pigs covered by the license shall not be disposed of except in accordance with the provisions of the Policy or in the manner specified by the licensing authority in the license.

The pigs for the import of which a license is granted shall be the property of the licensee at the time of import and up to the time of clearance through customs.

The pigs covered by the license for import shall not be exported without the written permission of the Director General.

Application Proforma

The application for import of pigs should be submitted in APPENDIX-8 (15 copies), APPENDIX-1A (in duplicate) and ANNEXURE 1, 2 and 3 to APPENDIX 8.

Documents to be Enclosed with the Application

1. Bank Draft/ Bank receipt evidencing payment of application fee.
2. Self certified copy of Proforma invoice from foreign breeder showing CIF value of the pigs.
3. Self certified copy of registration certificate issued by concerned authority.
4. Copy of recommendation of recommending authority.
5. Donor's letter in original in case of import of pigs as gift.

8.8 Health Conditions for Import of Pigs

The Department of Animal Husbandry and Dairying, Ministry of Agriculture, Government of India, krishi Bhawan would examine the case based on the latest disease situation of the Country of Import and India.

9. EXPORT OF PORK AND PORK PRODUCTS

9.1 Global Trade in Pork Products

World trade in pig meat is estimated at 3.73 million MTs valued at US\$ 9114 million (FAO, 1994). Europe is the largest exporter of pork accounting for about 80% of total world exports. Major exporting countries includes Netherlands, Denmark, China, France and UK. While Germany, Italy, Japan, France, Russian Fed., UK and Hongkong and Korea are the major importers. Asia accounts for about 10% of the total world trade in pork. The major importers of pork in Asia are Japan, Hongkong and Korea. China is the major exporter of pork .

9.2 Export of Pork and Pork Products from India

Indian Pig Industry is not an organized industry, however, the value of export of pork and pork products amounts to Rs. 13.66 million during 1996-97. The potential for Indian pork industry has been recognized by one and all but the industry has not developed on modern lines due to social, religious and economic constraints operating in pork sector. Most of the pig producers are landless laborers and small and marginal farmers. A large number of people engaged in the pork production belong to the low income group.

9.2.1 Role of APEDA

In order to assist private/joint sector for establishing abattoir and meat processing complex for export purpose a central sector scheme "Development of Technology and Infrastructure for Export Oriented Unit" was taken up by Agricultural and Processed Food Products Export Development Authority (APEDA) functioning under Ministry of Commerce, Government of India, New Delhi during 8th five Year Plan.

9.2.2 Export of Pork and Pork Products

Export of pork and pork products is desirable to promote Indian Pig Industry. Some of the advantages of exporting pig products are effective utilization of the surplus products available, earning higher rate of returns, creating more demand for the pork products, improving the production potential, adoption of better technologies and employment generation.

The pork and pork products are being exported to Philippines, Oman, Yemen, Brunei, Bahrain, Greece, UK, Malaysia, UAE, Kuwait, Germany and Senegal. During 1996-97 pork products valued at Rs. 13.66 million were exported. The details of the export of pork from India for the last 3 years is presented in Table 9.2.2.1. The country-wise export of pig meat for the last three years is presented in Table 9.2.2.2.

Table 9.2.2.1 Export of Pork from India

(Quantity in MT, Value in Rs. million)					
1994-95		1995-96		1996-97	
Quantity	Value	Quantity	Value	Quantity	Value
740.91	25.21	908	26.22	352.5	13.6

Table 9.2.2.2 Country-wise Export of Pig Meat

(Qty in MT)

Country	1994-95	1995-96	1996-97
Philippines	658.00		25.6
Oman	43.42	24.00	
Brunei	24.00		
Bahrain	15.50		
Greece	0.40	25.0	99.9
UK		25.5	
Malaysia		240.0	
UAE		619.0	89.2
Kuwait			96.5
Germany			25.2
Senegal			16.0
Total	740.91	908.0	352.4
Source-DGCIS, Calcutta			

9.3 Major Constraints affecting pork exports

About 1% of the total pork is processed into pork products in India, while in the developed countries more than 50% is processed into pork products. Processing pork into pork products is desirable to provide variety to the consumers, to utilize different raw materials, to reduce the cost of a particular product, to improve the nutrient content and to improve the marketability of the product.

Lack of Disease Free Zones

Most of the importing countries demand to source the pigs from areas free from Foot and Mouth disease, Swine fever diseases. Establishment of disease free zones would play an important role to promote pork exports at higher unit value realization.

Lack of Modern Abattoir or Pork processing Plants

There is an urgent need to establish pork processing plants on modern lines with proper inspection facilities to increase export of pork products.

Improvement of Domestic Slaughter Houses

It is necessary to improve the facilities of the large number of slaughter houses in order to improve the image of the Indian meat sector.

Lack of Gainful Slaughter Policy

Slaughter policy should support effective utilization of pig resources and promotion of sustainable pig production for maintains growth trends in pork exports.

Effective Meat Inspection and Quality Control

Directorate of Marketing and Inspection under administrative control of Ministry of Agriculture, Department of Agriculture and Co-operation is implementing "Meat Food Products Order, 1973 (MFPO), which covers only less than 15% of the total pork produced in India. There is an urgent need for effective meat inspection and quality control programmes in the pork sector.

10. ORGANIZATION AND INFRASTRUCTURE

10.1 The Enterprise and the Infrastructure

There are some prerequisites to a thriving Pig Industry viz. a favourable climate; an abundance of balanced and cheap feed; human population within the region that is skilled in and temperamentally adapted to handle the Pig enterprise; and finally, adequate market. Before taking the task of pig enterprise, a careful survey of its resources should be made. It will ascertain the availability of various factors which are essential for a pig enterprise including capital, land, feed, labour, equipment etc. Some of the requirements for the successful pig production are as follows:

10.1.1 Character of the Farm

There are certain conditions present in the farm itself influencing its suitability for pig production. It must have all the capability of producing an abundance of concentrates. Good quality legume hay may be produced in the farm. The farm must also provide an Opportunity to rotate the pastures as an essential step in the control of parasites. The condition of soil also helps for pig farming, although it is not essential to a good pig farm. Well drained land with respect to both surface and under drainage is highly desirable. Natural shade and running water are the essential requirements. The size of the swine enterprise can be adapted to the facilities that almost any farm provides. The land which is unusable can be used for non-productive purpose like construction of sheds, store house, roads and other buildings. A farm that possesses the other requisites including all weather roads and the suitable market nearby will be successful.

10.1.2 Ownership of the Land

The operator's ownership is desirable for successful pig farming. However, the product life cycle of pig farming is small and requires a small capital outlay and a little equipments.

10.1.3 The Capital Investment

The capital investment essential for a satisfactory swine enterprise is small in proportion to the sales from the enterprise. The capital investment plays an important role in limiting the

cost of production. On most pig farms, the tendency is to keep capital investment low and consistent with good management practices. The reduction on the investment in breeding animals may reduce their productivity, the quality of the offspring and ultimately returns from the enterprise. It is desirable to use good quality infrastructure to decrease death losses, feed waste and labour costs.

10.1.4 Equipment

The equipment plays an important role in pig farming due to the influence of the nature and arrangement to save on feed, saving of labour and the satisfaction derived from the enterprise. On an average, the building and equipment cost account for 5 to 10 per cent of the total cost of producing pork. The function of equipment is to protect the animals and feed and to expedite the work of caring, for them. To achieve high success, it is essential to equip fully with equipments, skill in planning individual places as well as their arrangement and utilization.

10.1.5 Feed and Land requirements

Feed is the greatest single item in the cost of producing pork accounting to about 70 to 75 percent of the total cost. The pigs are unable to utilize considerable amount of roughage. Therefore, cost and development of pig farming is governed by the supply of concentrates at cheaper rates.

10.1.6 Labour

The good organization and management of the pig enterprise reduces the labour cost. Small enterprise requires higher labour cost than large ones. The nature and usefulness of the equipment provided may also influence the amount of labour required to care for pigs. The introduction of self-feeder, adaptation of modern equipment reduces the labour by more than half. In a well managed farm, the labour cost account for 6 to 10 per cent of the total cost of producing pigs. Proper arrangement in buildings, the layout of roads and the use of pastures are important factors in keeping labour costs low. The distribution of labour in pig farming is fairly uniform except during the farrowing time. Additional labour is required during

farrowing season but it does not interfere seriously with the other farm work. The quality rather than the quantity of the labour available is important.

10.1.7 Skill of the operator

The skill of the farm manager is important, especially during the adverse business conditions like labour strikes etc. The burden of the manager is proportional to the size of the farm;

10.1.8 Maintenance of the Farm Records

Good records are absolutely essential for the successful operation of pig farming. Proper maintenance of records will reveal the weakness of the operation, and indicate the course to develop the enterprise in the direction of profit. In recent times, record keeping has become simple. Maintenance of adequate records are essential for financial assistance from the banks or other financial institutes.

10.1.9 Marketing

A good market is essential for satisfactory marketing for the pork and pork products. Now a days the demand for pork and pork products is increasing. The establishment of Government Bacon Factories and private pork processing plants have contributed to the availability of the market for farmers. Prices of pigs are also influenced by seasons, in some season it is on higher side. Packers pay higher prices for hogs of certain weights than they do for others. Some packers pay higher prices for cross bred hogs of high quality. The grading standards used by various buyers are not the same. Through careful planning it is possible to prepare the kind and weight of hogs that will top in the market. Efficient marketing of the products is essential for higher returns.

10.2 Functions of Pig Enterprise

Profits in pig enterprise is the difference between the cost of production and the net sale receipts of the pork etc. It can be increased by reducing the cost of production or by raising the selling price of the pork and pork products with no change in the cost of production, or by simultaneously changing both

factors on the directions indicated. Most pig farmers are extremely sensitive to the selling price of their animals, but seldom know even approximately their cost of production. Variation in the cost of production have greater influence than variations in the selling price on the profits to be derived from a pig enterprise.

Successful development and management of swine enterprise creates the need for understanding the nature and characteristics of pig industries.

1. Pig provides a market for feed and labour which are profitable.
The pig is an efficient converter of the feeds which are not consumed by man into pork and pork products which have a high nutritional value in the human diet. Many grains and seeds that could, be eaten by man are fed to swine because they are produced in abundance and because of the pork and pork products they produce have a higher nutritional value and are more palatable than the grains. Pigs make excellent use of many by-products which are totally unsuited for human food such as tankage, meat scraps, various oil meals and hotel and kitchen wastes.
2. Pig enterprise creates the profitable work for the available labour on the farm who otherwise might not have been employed. This business can be successfully combined with dairy or other farm activity.
3. In areas, where pigs are well adapted yield a profit constantly than other class of livestock.
4. The nature of pig affords two excellent qualities. Pigs are prolific and their reproductive cycle is short enough to permit quick increase in numbers.
5. In recent years, the pork production and demand for pork and pork products have increased in our country. But its demand is lower than that for other meats. The decline in the relative popularity of pork is due to two factors. (1) increased competition from other meats, especially poultry and (2) the quality of pork that has been produced. The price competition is highly critical of excessively fat pork cuts,

made serious inroads on Pork consumption. It is costlier than beef. Beef has always been the preferred meat of the low income group.

6. The pigs have the capacity to transform directly or indirectly the materials and energy contained in feeds into other forms more useful and desired by mankind. The condensing of feeds and other waste by-products of lower weight but higher nutritional value represents a tremendous saving in freight in marketing the products of the farm.
7. Pigs utilize certain by-products feeds that have no direct value in the human diet and not particularly well adapted to the feeding of other classes of animals. Slaughterhouse waste, tankage and fishmeal can be successfully used.
8. Pigs can utilize unsound and partly damaged feeds and grains which are rendered unmarketable.
9. Pigs utilize the waste products very efficiently. Table garbage, bakery waste, unmarketable fruits and many other products can be fed to pigs.
10. Pigs may increase the efficiency of other enterprises like dairy farming by utilization of the surplus labour.
11. Pigs aid in maintaining soil fertility. They produce the faeces with good manurial value.

10.3 Planning Pig Production

Planning is very important to set up pig production as a small enterprise to generate additional income. Many people have been attracted to pig production as an apparently simple means of making extra money but just as many have lost money and given up with disappointment. Before starting on investment in pigs it is essential to ensure that all aspects have been examined and that all the necessary links in the chain have been established.

The driving force in this enterprise is the market. It is essential to establish a market for pig meat, and it will pay a good amount of profit. The market is of course not fixed. It often happens that an initially small market can be expanded by producers who consistently make available reliable supplies of

an attractive product, competitively priced. In this way the enterprise can expand its own market. The questions required to be asked are:-

- *where is the demand for pork ?*
- *for what kind of product ?*
- *how big is the demand ?*
- *is it regular ?*
- *is it being satisfied at present ?*
- *can it be expanded ?*
- *what price is being paid ?*

The answers to these questions will give you some idea about how many pigs you might expect to sell and at what price. You might find, for example, that there was a competitive trade in fresh pork but unsatisfied demand for some specialized pig products such as ham, sausages. It would be more profitable to establish in one of these markets rather than trying to compete with established producers in an already stabilized market.

The size of the unit may be decided by physical limitations the land available for buildings, the amount of feed that can be obtained, the problems of waste disposal and so on or it may be decided by the desired output which may simply be the farmer's own requirement about the expected sales in the locality. Increasing the site requires more capital investment which may mean borrowing more money or losing the income for which the pigs are being kept. It also brings income risk of the possible collapse of the market and increases the problems of management and health control which always tend to be a greater problem in the large unit. A bigger unit also requires more and more of the farmer's time and energy.

10.4 Characteristics of Pigs and their Production

Pigs produce pork that differs from the flesh of all other animals in texture, flavor and certain nutritive properties. Because of the nature of their diet and their extraordinary rapid growth rate, they are extremely sensitive to unfavorable rations and to careless management. A person who desires to start pig farm and to make the best out of his pig enterprise must become

acquainted with the natural characteristics of swine and provide conditions that will permit them to function to their maximum capacity.

1. Pigs can utilize concentrates well and are efficient producers of human food. They convert small grains into pork and pork products very efficiently by utilizing rations which differ greatly in nature. They produce more live weight gain from a given weight of feed than any other class of meat animals.
2. Large acreages of land in our country are for one reason or another untillable and it can be utilized for pig farming.
3. It may be pointed out that in old civilizations not inhibited by taboos against the consumption of meat or other animal products but great population pressure has developed against food supply. The survival of pigs in India appears to be largely due to their ability as scavengers rather than to extraordinary efficiency they possess as converters of nutrients into human food.
4. Pigs were prized originally in this country because of their ability to store fat rapidly and their early improvement emphasized their capacity for this purpose. But now the trend has been changed and there is a demand for lean pig meat.
5. Pigs are prolific and bring quick returns. These grow rapidly, mature quickly and are prolific as they produce more number of pigs at birth can be managed to raise two litters in a year. Gilts may be bred at the age of about 8 months, and farrow when approximately a year old, and their pigs will weigh more than 60 kg by the time they are 6 months old.
6. The pig enterprise is flexible and farmer can increase the size of his operations as promise of increased profit appears. He may buy feeder pigs or he may manage the pigs of a bred which produces two litters per year. A reduction in the size of the enterprise may be achieved as desired. This very flexibility, is advantageous specially for the price fluctuations in the market and prevents the possible loss.
7. The pig enterprise requires moderate investment.

8. Pigs can be sold well at a wider range of weights. Slaughter prices are regularly quoted on all weights, from 50 kg to 150 kg. The wide weight range over which hogs may be sold to advantage permits considerable choice at the time of marketing the crop of pigs. If the price is not satisfactory at a given time, the pigs can be held for a higher market.

10.5 Factors which effect cost of Production

There are a number of factors which support their production as a vigorous industry. As a safeguard against disappointment and perhaps even failure, preparatory consideration should extend to the actual problems that will be met in starting and maintaining a farm.

10.5.1 Number reduce costs

The intensive production in this industry has been made possible by the ingenuity of swine growers in devising and adapting new equipment and methods of handling sows during the farrowing season, so that the operator can now successfully handle more number of sows and litters. The increase in size of operation, usually increases profits. The economics of size of pig producing farms in India are maximum when farms reach about 30-45 sows. It is important to emphasize that the combination of site and superior management will lead to reduced cost of production.

10.5.2 Major or Minor enterprise

On many farms that provide the requisite physical requirements, as outlined earlier, swine production is a major enterprise and regularly serves as a principal source of income. Under other conditions it functions equally well as a minor enterprise. The greatest success in pig farming comes only with the experience. It is well to begin with small numbers and increase the size of the operations gradually as the adaptability of the farm and one's own ability as an operator are revealed by profits from the enterprise. As a minor enterprise swine production can be made to supplement several different enterprises. The size and nature of herd vary with conditions. It may consist of several brood sows which are maintained to

produce the desired pigs, or the required number of pigs may be purchased as feeders.

10.5.3 Purpose of the Herd

The great majority of pigs are raised for the purpose of producing pork, though a smaller number are maintained primarily as a source of improved breeding stock. The sale of pigs which are to be used for breeding purposes has traditionally been restricted to purebred herds and Government Pig Breeding farms. The competition demands that breeder should develop intelligent programmes that will keep their herds highly productive for commercially important characters including high carcass quality. The breeding of animals requires special skill not possessed by every one, and how well they are sold may even be the determining factor in the success of the entire enterprise. A purebred requires a greater investment than a grade herd and is more expensive to maintain.

10.6 Small scale versus Commercial Pig Production

The small scale pig farmer has no chance of keeping pigs as efficiently as can be done in a large unit. The large commercial farmer has some advantages, he can carry a greater number of breeding stock and make more effective genetic selection, he can buy his requirements in large quantities and at lower prices, he can achieve economics of scale in the use of labour and other inputs.

However, the small farmer has advantages of his own. He can probably build the house cheaply with his own labour, members of the family can help in the work in free hours; the wastes and by-products from the house and farm, from neighbors and local industries can form an important part of the feed requirement, less chances of major disease problem; and dung and urine are a valuable resource rather than a nuisance. The small farmer is at greatest advantage in the use of locally available feeds. The various often wet and bulky materials are available to small scale production units because they are difficult to handle mechanically and not easy to incorporate in compound feed.

The big unit requires a large, regular and reliable supply of its feed ingredients. The cost of production of small farmers is lower and can accept a slow rate of growth.

10.7 Advantages and problems of Pig keeping

The pigs are primarily maintained for meat production. The main advantages of pig keeping are:

1. Pigs are more efficient converters of crops into meat than other domestic animals.
1. Pigs do not require specific crops. They can thrive on a great variety of plant material including roots, stems.
3. Pigs can utilize by-products and waste from household, farm or industry which might be thrown away.
4. The pigs are prolific breeders and can produce more than 2.0 litters per year.
5. Pigs do not require a large capital investment but they do provide quick returns on investment.
6. Pigs require a little space.
7. All parts of the carcasses are useful.

There are some drawbacks of pig farming.

1. Pigs are competitors for some items of human food.
2. Pig meat is not universally liked; muslims in particular do not eat it.
3. Pigs can cause pollution and nuisance - smell, flies and noise.

11. BY-PRODUCTS INDUSTRY

The conversion of raw materials in the best possible manner at the point of availability. The conserved raw materials can later be processed into end products at an industrial establishment.

11.1 Advantages of By-products Industry

11.1.1. Industrialization of By-Products Industry

A number of secondary industries such as the manufacture of crushed bone, bone ash, bone glue, brush, horn and hoof meal, glue and gelatin, livestock mineral mixture, animal feeds, leather, sausage casings, surgical and sports guts, sandpaper, safety matches, gum tapes, soap, candle etc. can be established.

11.1.2. Employment Generation

The modernization of by-products industry would generate substantial employment to the rural poor specially backward classes.

11.1.3. Resource Utilization

In India, there is a acute shortage of protein feeds and fertilizers. Since protein meal and fertilizers are the main products manufactured from the many animal offals, its use would increase the agricultural production.

11.1.4. Effluents and Pollution

There is an acute problem of pollution due to non-utilization of slaughter house wastes. The conversion of animal wastes will ensure a clean environment, providing better and healthier living conditions for the population.

11.1.5. Solar Energy

In India, solar energy is abundant for most of the year and rains are seasonal. The conservation of raw material at the rural level require the maximum use of solar energy.

11.2 Availability of Animal By-products

The availability of animal by-products is influenced by a number of factors such as buying power of the consumers, religious beliefs, customs and eating habits of the population. The typical inedible offals which are being wasted at present are: hides and skin, blood, rumen contents, bones, horns and

hoofs, urinary bladder, intestines, gall bladder, rectum, uterus, penis, udder, fetus, tail hair, ear lobe, pig bristles and body hair, hide and skin trimmings, condemned meats etc.

11.3 Collection, Processing and Utilization

In India, the available by-products are either totally wasted or not optimally utilized. There is an urgent need to collect, process and utilize them for maximizing profits in this industry.

11.4 Pig Products and their Value

Pigs are slaughtered primarily for meat. However, the process of meat production yields a number of value added products and by-products. These by-products of pig meat fall into two groups, the edible and non-edible.

11.4.1. The Edible By-products

The edible by-products include tallow, lard, guts, glands, tail stumps and blood.

Intestines

There is a great demand for casings. Pig intestine is used for sausage production.

Glands

Edible glands are generally sold along the pork for human consumption.

11.4.2 In-edible By-products

The inedible by-products includes hair, casings, blood, hooves and condemned meat. These by-products are used for the production of various consumer goods, such as casings, guts, pharmaceutical products, animal and poultry feeds and fertilizers.

Bones

The bones are not fully utilized due to its collection and lack of processing technology. Bones are used for preparation of bone-meal and fertilizer. A large number of bone-based products like crushed bones, bone glue, ossein and gelatin are being manufactured.

Blood

In India, the blood is not utilized properly and is being wasted. It can be used for preparation of blood meal. It is of

considerable value and can be put to a variety of uses, such as livestock feed, manure and medicinal and industrial purposes such as preparation of albumen, gluing of plywood, dyeing of textiles and paper and dressing of leather before dyeing.

Glands

Glands such as thyroid, parathyroid, and pituitary are valuable for manufacture of glandular products for medicinal purposes, are generally not put into proper use. This is due to lack of modern processing facilities. These endocrine glands may yield valuable medicines such as pepsin, pancreatin, adrenalin, pituitrin, insulin and thyroid extract. Ovary yield estrogen which is used in the treatment of menopausal syndromes and progesterone to prevent abortion.

Useless Pork

The major portion of useless pork is allowed to go waste and about 40% is used as animal feed mostly for pets. If it can be processed, the wastage can be prevented.

Hooves

About 45% of hooves of pig are wasted and not processed for production of hoof meal.

11.5 Bristles

The Indian bristle is of very high quality. The bristles are mostly obtained from the indigenous domesticated pigs. Small quantity of bristles are also obtained from the wild and semi-wild boars. The bristles are long, stiff, wiry hair which grows mainly on back and neck of pigs, hogs and wild boars. Pedigree pigs produce poor quality bristles. The best bristles are found in Northern- India. The bristles are used for manufacture of brushes.

11.6 Biomass Production

The large quantity of pig faeces from medium and big farms and their relative low value in the marketplace has prompted a search for schemes to produce a product from pig faeces that will yield a more attractive return than conventional uses as manure.

11.6.1. Algae Production

Algae can be grown in the diluted liquid fraction of pig



Fig. 11.6.3.1 A Pig-Fish Farm of Manipur



Fig. 11.6.3.1 A close-up of Pig-fish farm of Manipur

manures. The major advantage of algae over terrestrial crops are high yield per acre and high protein content. Algae yields of over 275 tons/acre of dry matter containing 50% protein.

11.6.2. Yeast Production

The soluble organic carbon fraction of pig manure is potentially useful as substrate for yeast in a continuous flow fermenter having a residence time of 3 to 5 hr. The yeast product is usable as a feed ingredient.

11.6.3. Fish Production

The growth of fish, carp and tilapia in ponds fertilized with liquid pig manure is common in Singapore, China and many parts of the world. Fish yields of 90-450 lb./acre are achievable in extensive open pond culture systems. It renders into fish production of about 6000 lb. annually for a 100 pig production.

11.7 Bio-gas from pig waste

The rapid rise in the prices of fossil fuels and their scarcity all over the world have aroused interest to develop newer sources of energy from renewable sources which are abundant quantities. Among these, pig faeces and liquid waste is considered to be the most attractive source, since it is available at farm free of charge. Bio-methanation provides fuel in the form of methane, high value digested slurry as manure and enriched effluent for irrigation purpose. It also help to minimize the level of pollution and thus maintains good sanitary conditions in the area of piggery farm.

Bio-gas gas can be produced from pig waste water and slurry. Biogas is a versatile fuel and can be used for cooking, lighting and running of engines. Special types of lamps and gas burners are commercially available for lightning and cooking. Petrol and diesel engines can be suitably converted to run on biogas. Dual fuel engines have been developed to run on 80% biogas and 20% diesel.

The pig slurry should be processed before it can be utilized in fish ponds. It can be utilized as anaerobic digestion to produce farm gas. The digestive treatment of slurry will reduce the polluting power by as much as 80% and it eliminates displeasing

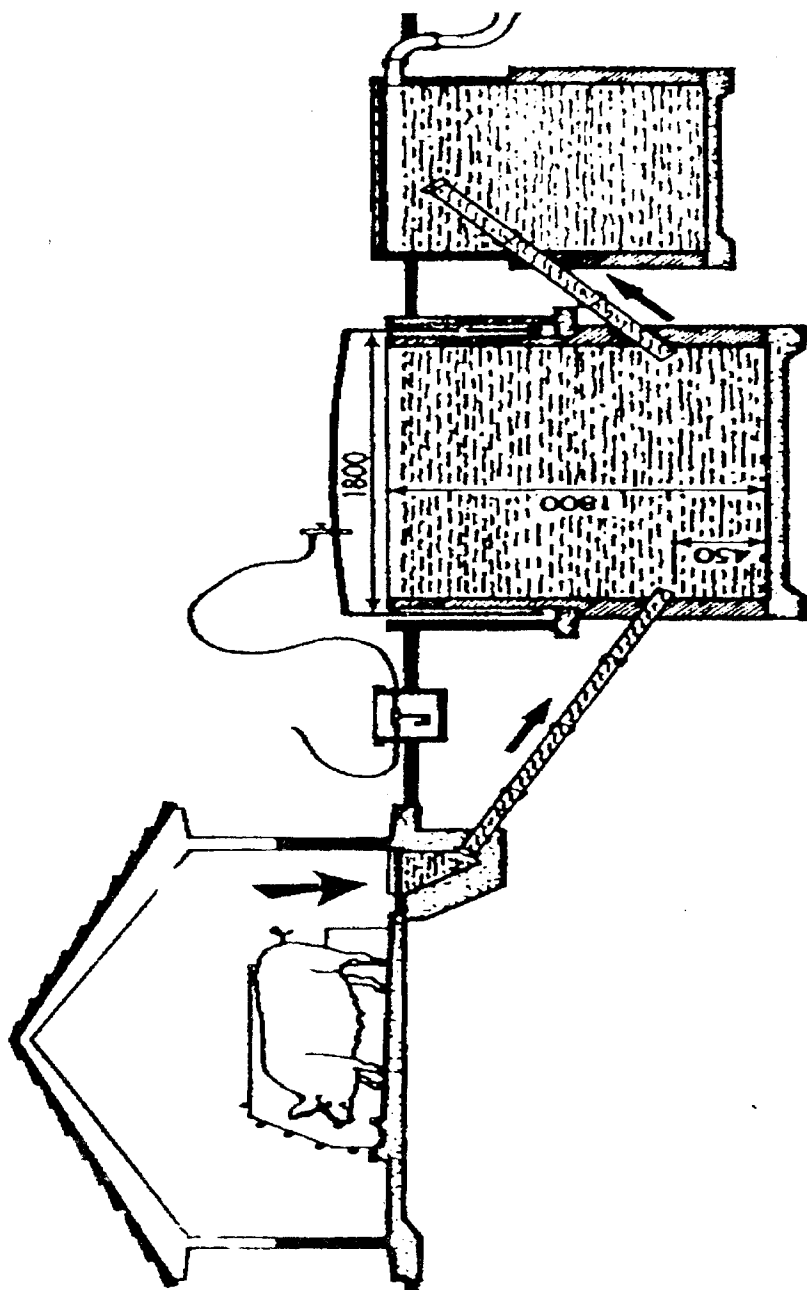


Fig. 11.7.1 Bio-gas from pig waste

smells. During digestion all pathogens and weed seeds are destroyed, so the rest product can be spread on the fields. Once started up, the gas digester runs entirely on the methane gas produced by the process itself, reducing the running cost very low. A substantial amount of excess gas remains for utilizing for heating or electrical power for farm house.

Biogas is produced by anaerobic fermentation in which complex organic substances are broken down into less complex soluble organic compounds by enzymatic hydrolysis. The acid forming anaerobic bacteria converts soluble organic compounds into simple organic acids, viz. acetic acid, which is later converted into methane and carbon dioxide by methanogenic bacteria.

Advantages

1. Biogas is a clean cooking fuel.
2. There is reduction on fuel budget, saving on fuel wood, reduction in the pollution for women's lives and improvement in rural sanitation.
3. The spent slurry is an excellent manure, which improves the soil structure and water-holding capacity.
4. The spent slurry is also an ideal medium for mushroom cultivation, feed for fish and algal protein production.
5. Methane is one of the green house gases responsible for global warming, and the emission of methane can be minimized by biogas and bio-fertilizer production.
6. Biogas slurry in conjunction with the chemical fertilizer can be used to improve the condition of the soil.
7. Biogas technology is cheap, simple and can be adopted by the pig farmers in the rural areas.
8. Biogas is not only pollution free but eco-friendly for clean environment, better sanitation and hygiene and convenient utilization of waste.
9. Biogas is a fit option for rural pig farms and cooking and lighting applications.

11.8 Bio-fertilizer from pig waste

The pig faeces can be used for production of bio-fertilizer

with the help of micro-organisms like *Azotobacter*, *Azospirillum*, Blue-green algae, *Rhizobia*, *Acetino-rhiza*, *Azolla*, *Mycorrhiza*, Phosphate Solubilising bacteria. If these micro-organisms are provided favorable conditions, they decomposes the pig faeces to form bio-fertilizers.

The spent slurry after bio-gas generation can be used for production of bio-fertilizers. The bio-gas slurry can meet up to 40-50% of the crop's nitrogen needs without affecting the grain yields.

The average production of excreta per pig/year amounts to 0.25 ton. The nutrient content of pig faeces are more than cow dung and sheep and goat excreta. The pig faeces contains 2.27 N, 3.1 P₂O₅, 1.8 K₂O, 0.21 Ca, 0.54 Mg (% on dry basis). It also contains micro-nutrients (ppm) 1200 Fe, 50 Zn, 70 Mn and 8.9 Cu.

Advantages of bio-fertilizers

1. The indiscriminate use of chemical fertilizer would be reduced, thus reducing the cost of agriculture production.
2. The threat to the sustainability of agriculture production would be minimized.
3. These are eco-friendly and useful for pollution free healthy life and environment.
4. Bio-manure is safest and healthy manure as compared to inorganic chemical fertilizers.

12. ANATOMY AND NAME FOR AGE & SEX

The knowledge of anatomy of pigs is essential to understand the behavior and physiology of pigs.

12.1 Name for Different Age and Sex

The naming of pigs at various times of their life is based on age and sex and castration. The following are the common name used.

Piglet:- A young one from birth to weaning.

Store pig:- A pig between the time of weaning and being fattened.

Gilt or Yelt:- A female intended for breeding and up to the time that she has her first litter.

Boar, Bran or Hogg:- An uncastrated male for breeding.

Sow:- A breeding female after the first farrowing.

Hog:- A male pig after being castrated.

Stag, Steg or Seg:- A male castrated late in life.

12.2 Abdomen of Pig

The stomach is situated between the liver and diaphragm and the mass of intestines. The small intestine is 50 to 60 feet long and are arranged in small coils chiefly on the left side and floor of the abdomen from the stomach to the pelvis. The large intestine lie high up on the left side except for the caecum, which is found towards the right flank. The variation in the position of intestine is influenced by age and stage of pregnancy. The liver lies in the anterior part of the abdomen between the diaphragm and the stomach and duodenum. The pancreas lie up against the right kidney. The spleen is situated under the last three ribs on the left side, and from here it passes downwards and forwards to the lower abdominal wall.

12.3 Digestive System of Pig

The Mouth

The upper lip is thick and short, and is blended with the snout. The lower lip is small and pointed. The mucus membranes of the cheek is smooth. The rima oris is extensive. The hard palate is long and narrow. The soft palate is very thick and is about 5 cm long in medium sized animal. The tongue is long,

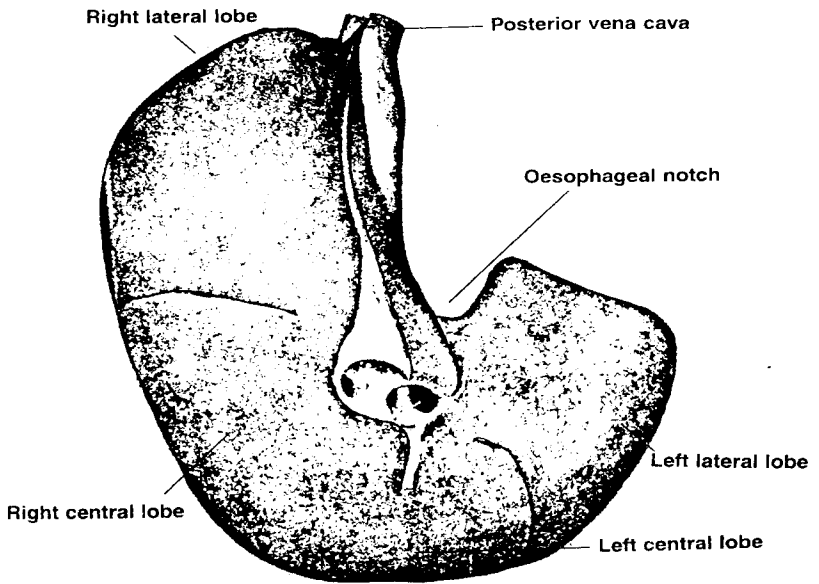


Fig.12.3.1 Liver of pig

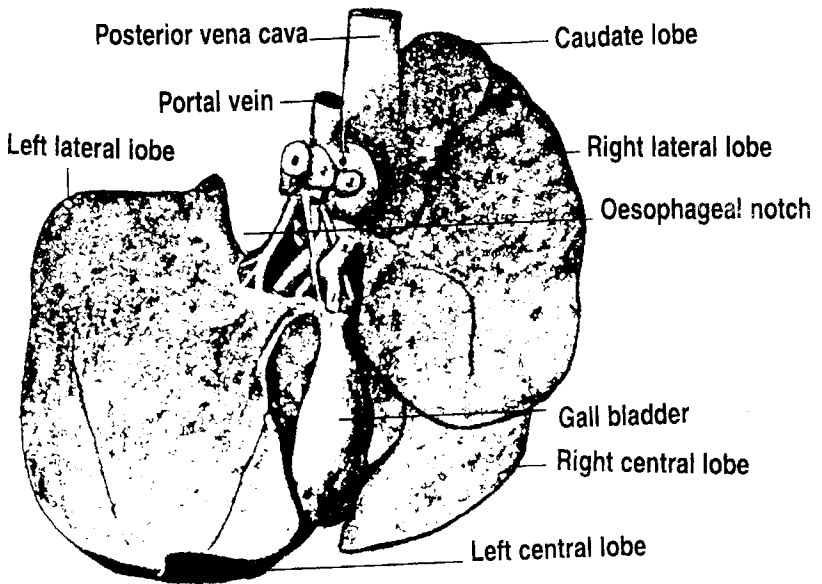


Fig. 12.3.2 Liver of pig

narrow and the apex is thin. The fungiform papillae are small and most numerous while filiform papillae are soft and very small.

Dentition of Pig

At birth the little pig has two pairs of sharp-pointed teeth in each jaw, top and bottom, placed so that there is a distinct space between each pair. There are two temporary tusks and the two temporary corner incisors.

Tusks or canines

The tusks are greatly developed in the entire male, and both upper and lower tusks project out of the mouth. The upper canines of a boar may be 3 to 4 inches long. The lower tusks may reach up to 8 inches long in an aged animal. Each has a large pulp cavity from which the tooth continues to grow throughout the animal's life. In wild boar tusks are well developed and visible from a distance.

The temporary dentition of pig includes 6 incisors, 2 canines and 6 molars in upper and lower jaws.

The permanent teeth are distributed in upper jaws and lower jaws, the upper jaws have 6 incisors, 2 canines and 14 molars, while lower jaws also have 6 incisors, 2 canines and 14 molars.

Pharyngeal Region of Pig

The parotid gland is large and distinctly triangular. The mandibular or submaxillary gland is small, reddish in colour and oval in outline. The sublingual gland is similar to that of ox. The posterior part is reddish-yellow in colour, and is about 2 inches long and half inch wide.

Pharynx

The pharynx is about 1 to 1.5 inch long, which is situated between the ventral straight muscles of the head and the origin of the oesophagus.

Its ventral margin is formed by the junction of the posterior pillars of the soft palate, which contain muscular tissue derived from the palatinus and palato-pharyngeus.

The Oesophagus

The oesophagus is short and nearly straight. The muscular

coat is striated except near the cardia, where the deep part is unstriped.

The Stomach

The stomach is large and its average capacity is about 5.7 to 8 liters. The left part is large and rounded and right part is small and bends sharply upward to join the small intestine. The oesophagus joins the stomach very obliquely just to the left of the median plane.

The Intestine

The intestine is about 15 times the length of the body. The small intestine is 50 to 65 feet long. The first part of the duodenum turns sharply medially on the visceral surface of the liver to the right of the portal fissure. The right end of the pancreas is attached to the first part, and here the pancreatic duct opens into the bowel. The opening of the bile duct is 1 to 2 inches from the pylorus. The large intestine is about 12 to 15 feet in length and is for the most part much wider than the small intestine.

The caecum is cylindrical and about 8 to 12 inches long and 3 to 4 inches wide. It lies against the upper and anterior part of the left flank and extends ventrally, backward, and medially behind the coiled part of the colon. Its dorsal end is directly continued by the colon. The ilium joins the caecum obliquely and projects considerably into the latter. The rectum is surrounded by a quantity of fat.

The Liver

The liver is relatively large and its weight is about 1.5 to 2 kg. It is thick centrally, but thin at circumference. It is divided into 5 lobes, right lateral, right central, left central and left lateral. On the upper part of right lateral lobe, is the caudal lobe. Its visceral surface is deeply concave, most of it is related to the stomach. The gall bladder is attached in the fossa vesicae felleae. The bile duct opens at the papilla duodeni about 1 to 2 inches from the pylorus (Fig. 12.3.1 and 12.3.2).

The Pancreas

The pancreas extends across the dorsal wall of the

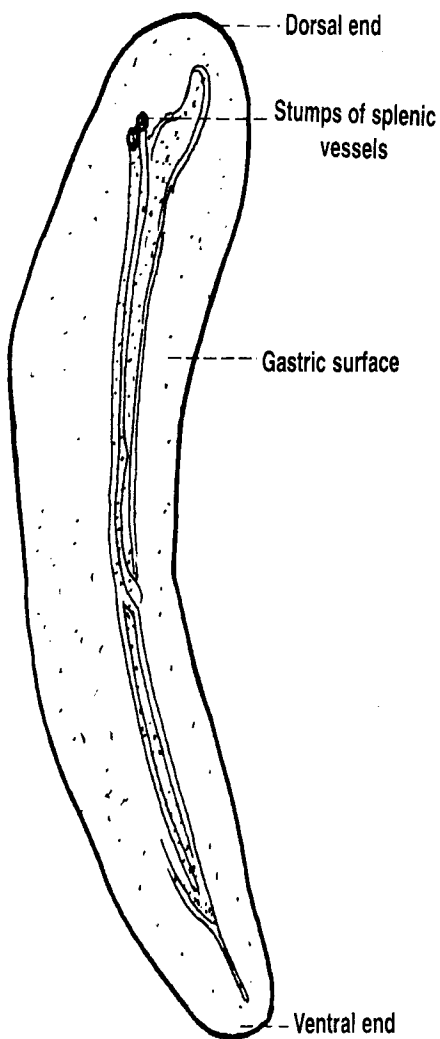


Fig. 2.3.3 The Spleen of Pig.

abdominal cavity behind the stomach. It is triangular in shape. The right extremity is attached to the first curve of the duodenum and left extremity is related to the left extremity of the stomach. The pancreatic duct passes from the right extremity directly through the duodenal wall, opening about 4 or 5 inches from the pylorus.

The Spleen

The spleen is long and narrow. Its long axis is nearly dorso-ventral in direction, and is curved to conform to the left part of the greater curvature of the stomach.

Its dorsal end lies under the vertebral ends of the last three ribs, it is related to the stomach in front, left kidney behind and the left extremity of the pancreas medially. The length of the spleen is about 25 inches and width is 3 to 4 inches. The weight of the spleen varies from 200 gm. to 350 gm (Fig. 12.3.3).

12.4 Skeleton System of Pigs

The skeleton of the pig is comparatively small for the external size of the animal. This is attributed to the excessive deposit of fat and partly to the fact that the bones are more dense and close in structure than in other domestic animal. The bones are more stronger in proportion to their size (Fig. 12.4.1).

The Skull

The Skull is an irregular pyramid in outline and remarkable for the great size and strength of the frontal bones. The capacity of cranium is lesser than that of the horse. The orbits are small and the margin of each is incompletely laterally and below. The face has a characteristic four-sided form, a tolerably abrupt edge marking the line of articulation of the nasal bone with the maxilla and premaxilla.

The anterior openings of the nasal chamber are situated almost at the anterior extremity of the skull and the nasal peak is short. The relatively enormous length of the bony palate is very notable, which forms two-third of the whole length. A very large canine teeth known as tusk is present in adult male and a small bone is situated in the snout (Fig. 12.4.2 and 12.4.3).

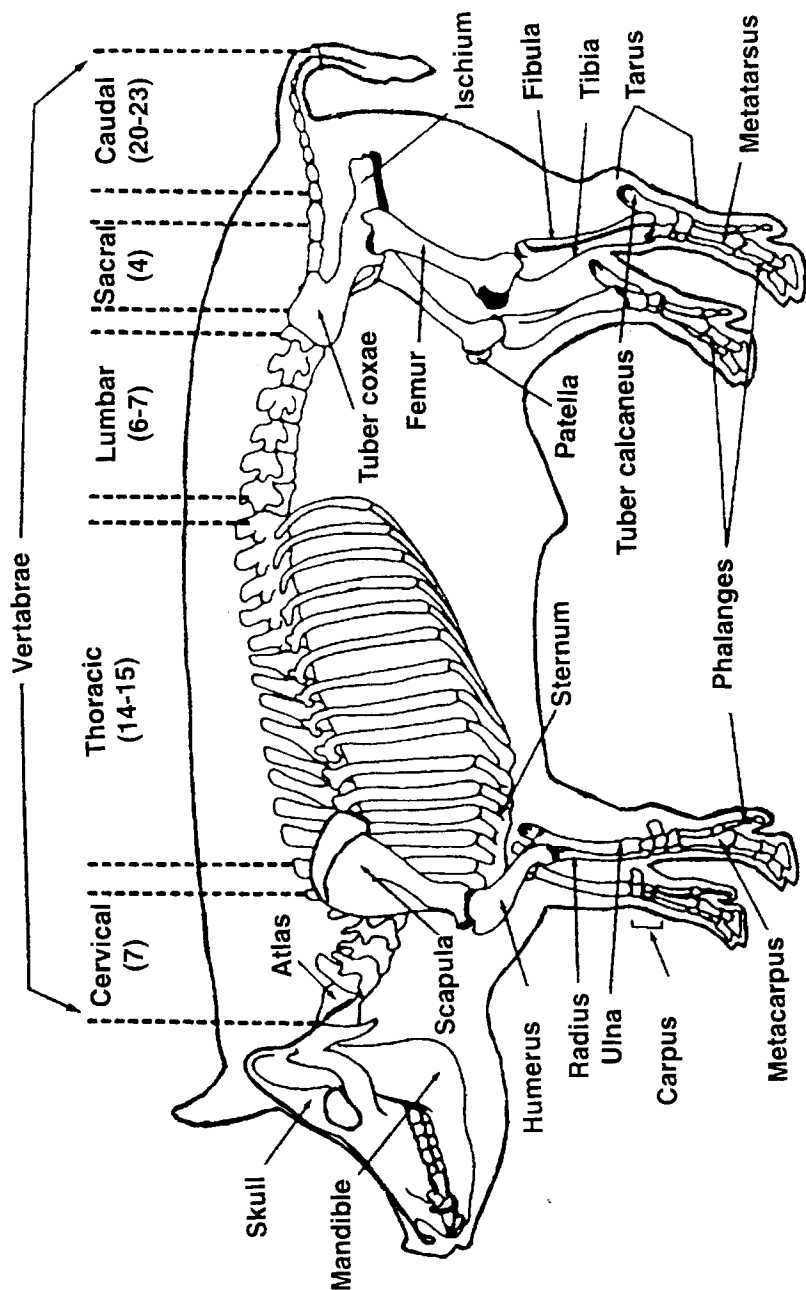


Fig. 12.4.1 The Skeleton of Pig

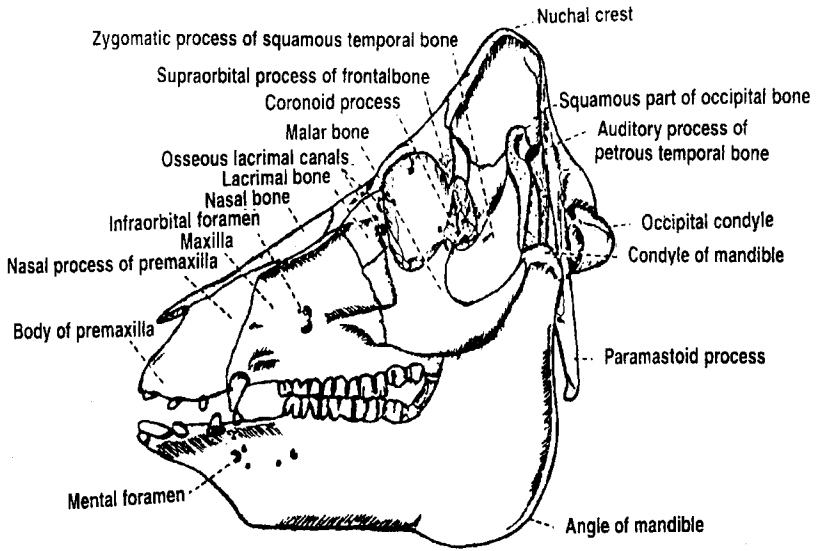


Fig. 12.4.2 The Skull of Pig

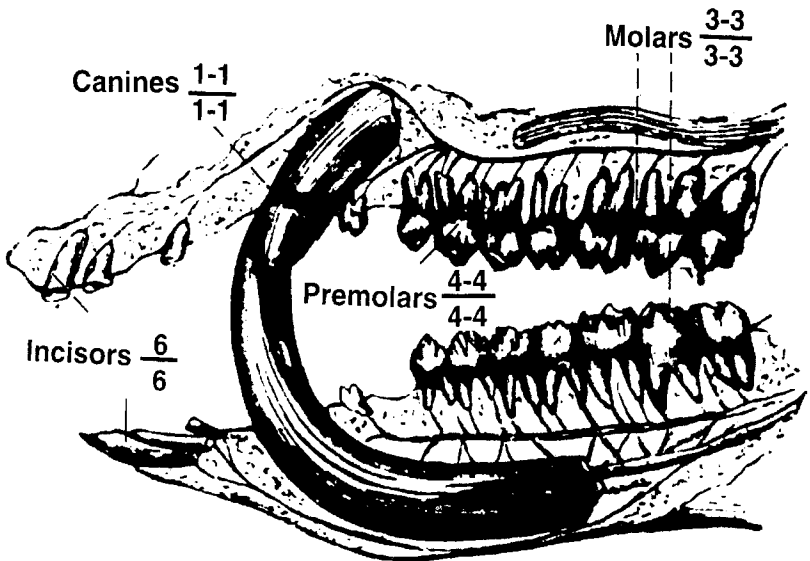


Fig. 12.4.3 Dentition of Wild Boar

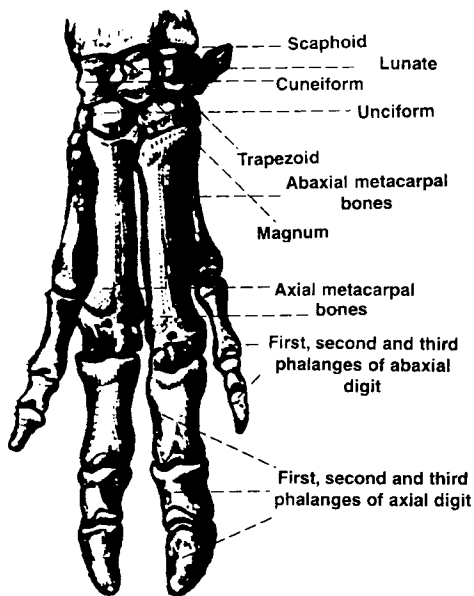


Fig. 12.4.4 Skeleton of Wild Boar's foot

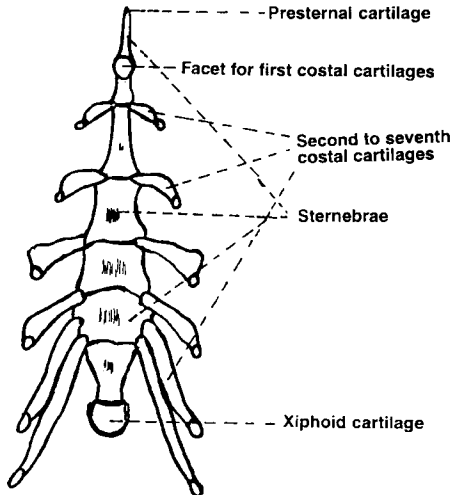


Fig. 12.4.5 Sternum of Pig

Vertebral Column

The vertebral column is made of 7 cervical bones, 14-15 thoracics, 6 to 7 lumbar, 4 sacral and 20-30 coccygeals. The cervical vertebrae are very short and wide. The sacrum is made up of 4 bones which are fused. The coccygeals are small. The rib number is 14 or 15 pairs, which are markedly curved in the improved domestic breeds but straighten in wild pigs.

Sternum

The sternum consists of six segments and resembles that of ox. The first segment is long, flattened laterally and bears a blunt-pointed cartilages. The thorax is long and more barrel shaped than ox due to the more strongly curved ribs (Fig. 12.4.5).

Bones of the Fore Limb

In forelimb, all the bones are comparatively shorter than other domestic animals. The scapula is wide and short and carries a wide spine. The humerus is bent somewhat like the italic "f" without the cross-bar. The radius is small, short and narrow with a soft shaft. The ulna is larger than the radius. The corpus is consists of 8 bones, 4 in each row. Metacarpals are 4 in number, the two central being larger than those on the outsides. Each of the digit possesses 3 phalanges and 3 sesamoids.

Bones of the Hind Limb

The hind limb shows a femur, tibia and fibula whose shafts are separated by a wide space and a tarsus of 7 bones.

The pelvic girdle is flatter and wider and not very deep. The inlet of the pelvis is elliptical and oblique and in an average sow measures from 5 to 6 inches vertically and about 3.5 to 4 inches transversely.

The patella is very much compressed transversely and presents three surfaces. The tarsus comprises 7 bones. The 4 metatarsal bones resemble the corresponding bones of the fore limb, but are longer. The first and second phalanges are little longer and narrower than those of the forelimb.

12.5 Respiratory System of the Pig

The Nasal Cavity

The nostrils are small and are situated on the flat anterior

surface of the rostrum or snout. The snout is a short cylindrical projection, with which upper lip is fused. The skin on the snout is thin and highly sensitive and contains small pores, and scattered over it are fine short hairs. Between the nostrils, in the snout is the *os rostri*, which is to be regarded as a special development of the extremity of the septum nasi in adaptation to the habit of burrowing or rooting. The nasal cavity is long and narrow which is divided into an upper olfactory part and a lower respiratory part.

The Larynx

The larynx is remarkable for its great length and mobility. The cartilages are more loosely attached to each other. The cricoid cartilage is thick and compressed laterally. The thyroid cartilage is very long. The epiglottis is relatively very large and is more closely attached to the hyoid bone than to the rest of the larynx. The vocal cords are directed obliquely downward and backward and each is pierced by a long, slit-like opening, which leads into the large laryngeal sacculle.

Trachea and Bronchi

The trachea is about 6 to 8 inches long and contains 32 to 35 rings, which overlap dorsally. It is slightly depressed dorsally, except the terminal part, which is circular in cross-section. A special bronchus is detached for the apical lobe of the right lung. In the left lung the stem-bronchus gives off a bronchus which divides into two branches for the anterior part of the lung and continues backward in the diaphragmatic lobe.

The Lungs

The right lung has four lobes, apical, cardiac, diaphragmatic and intermediate. The left lung is divided into two or three lobes. The diaphragmatic lobe is clearly marked off by a fissure.

The lobulation is distinct, but the interlobular septa are thinner than in the ox.

The Thyroid Gland

The thyroid gland is large and situated usually at a considerable distance from the larynx, but may be in contact with it. The lateral lobes are irregularly triangular in outline.



Fig. 12.6.1 Genital Organs of a boar.



Fig. 12.6.2 Genital Organs of a sow.

The Thymus

The thymus is relatively very large, extending to the larynx or even to the mandibular space.

12.6 Reproductive System of Pig

Genital Organs of the Boar

The testicles are very large and are regularly elliptical in contour. The scrotum is situated a short distance from anus and not so sharply defined as in other domestic animals. Testicles are comparatively soft in texture. The epididymis is closely attached to the testicle. The spermatic cord is very long, 20-25 cm. in a boar of medium size. The ductus deferens is closely attached by the tunica vaginalis. The vesicula seminalis are exceedingly large, and extend into the abdominal cavity. The prostate consists of two parts, the body is 2.5 inch wide and overlies the neck of the bladder and the urethra at their junction. The bulbo-urethral glands are very large and dense and somewhat cylindrical and lie on either side of and upon the posterior two-thirds of the pelvic urethra. The penis resembles that of ox but sigmoid flexure is prescrotal. The anterior part has no glans, and spirally twisted, especially in erection. The penis in an adult boar measures about 18 to 20 inches in length. The prepuce has a narrow orifice which is surrounded by stiff hairs. The urethra has a very long pelvic part, which is covered by a thick urethral muscle (Fig.12.6.1).

Genital Organs of Sow

The reproductive tract of sow consists of ovaries, oviducts, uterus, vagina and external genitalia. The ovaries are oval in shape in maturity having a mulberry like appearance due to multiple follicles and or corpora lutea. These are enclosed in the purse of the peritoneum. The uterine body is short, but uterine horns are long and convoluted, measuring up to 1.5 m in pregnant animals. The cervix is poorly defined, being characterized by a thickened wall with the vagina is 7.5 to 11.5 cm long, smaller in diameter with a thick muscular coat. The vulval labilae is fairly thick and covered with a wrinkled integument. The vestibule is fairly long and vestibular glands are small in number (Fig.12.6.2).

13. BREEDS AND BREEDING OF PIGS

The primary objective of swine production is to get maximum lean meat in the form of bacon and ham.

However, a small number are maintained primarily as a source of improved breeding stock. The sale of pigs which are to be used for breeding purpose has traditionally been restricted to purebred herds at Government Pig Breeding farms. In recent years, with the introduction of purebred stock of exotic pigs and improved method of breeding, this industry is expected to play a significant role in the economy of the country.

13.1 Pig Breeds of India

13.1.1 Indian Breeds

The production potential of indigenous pigs is very low. The indigenous or desi pigs are classified as a distinct group as a result of gradual domestication of wild pigs to their surroundings. These pigs differ in their characteristics and colour from region to region. Females possess 6-12 teats. Adult pigs weigh up to 168 kg. Indigenous pigs are mostly slaughtered and consumed as fresh pork. The indigenous pigs are generally black or dark brown in colour and vary considerably in size and type.

13.1.1.1 Wild Pig Relatives

The wild pig relatives lack in grace and beauty but they are known for their strength, adaptability and intelligence. They are admirably adapted to range the forests, thickets, woodlands and grasslands. They are the most generalized of the living even-toed hoofed mammals and have a simple stomach. The living wild pigs are medium sized artiodactylous characterized by a large head, short neck and powerful, but agile, body with a coarse bristly coat. The eyes are small and expressive ears fairly long. The prominent snout carries a distinctive set of tusks (lower canine teeth) and ends in a mobile, disk-like nose pierced by the nostrils. The structure of the snout, tusks and facial warts is intimately linked to diet, mode of feeding and fighting style. The tasseled tail effectively swats flies and signals mood.

The key features of wild pigs are the well developed, unturned canines, molars with rounded cusps and a prenasal bone.



Fig. 13.1.1.1.1 A Close-up of Wild Boar



Fig. 13.1.1.1.2 An ancestor of Domestic Pig

which supports the nose. Pig walk on the third and fourth digits of each foot, while the smaller second and fifth digits are usually clear of the ground.

The senses of smell and hearing are well developed. Pigs are highly vocal and family group communicate incessantly by squeaks, chirrups and grunts. A loud grunt may herald alarm, while rhythmic grunts characterize the courtship chant.

Sexual maturity is attained at about 18 months, although males may only gain access to sows on reaching physical maturity at about 4 years old. Pigs may breed throughout the year in the moist tropics but in temperate and tropical areas of marked season. The mating occurs in the fall the sow farrow the following spring. The young one are born in a grass nest constructed by the sow and weigh between 500 to 900 g. The piglets remain in the nest for about 10 days before following their mother. Each piglet has its own teat. Weaning occurs at about three months of age, but young piglets remain with their mother in a closely knit family group until she is ready to farrow again.

13.1.1.1 The Indian Wild Pig (*Sus scrofa cristatus*)

The Indian Wild Pig (*Sus scrofa cristatus* **Wagner**) is found in the Himalayan jungles up to an elevation of 4500 m. It measures 150 cm from nose to vent and 86 cm at the shoulder, and exceeds 136 kg in weight. The males are larger than females. Wild boars in West Bengal are heavier than those in the Punjab and the Southern Peninsula.

It is also found in Ceylon and Indian range of Periyar sanctuary of Kerala, Mudumalai Sanctuary and Pt. Calimere Sanctuary of Tamil Nadu, Bandipur Sanctuary of Mysore, Kawal Sanctuary of Andhra Pradesh, Raigoda Sanctuary and Usha Kothi Sanctuary of Orissa, Hazaribagh and Palamau of Bihar, Kanha, Shivpur and Churna of Madhya Pradesh and Taroba of Maharashtra.

The wild pig has a long snout, short ribs and long legs. It is rusty in colour when young, but with advancing age becomes dark chestnut-brown. The hair being tinged with grey at the

extremities. It has a sparse coat, with a full crest and a mane of black bristles running from the nape down the back. The tusks are well developed in males and project from the mouth. The pig is extremely active, and when provoked may attack humans. It is highly prolific and breeds in all seasons. The diet consists of roots, tubers, insects and snakes.

The boar is considerably larger than the sow. The height of well grown boar measures at 3 feet and its weight around 500 lb. The shoulder height generally ranging from 70-90 cm and the weight from 90-135 kg. The nuchal crest or mane is well developed. The body coat is scanty and devoid of underfur. The lower tusks of the boar reach a length of 25 cm and are kept with sharp edges by wear against those of the upper jaw. These pigs are crop-raiders, and do substantial damage to groundnut, digging up an entire field overnight. The pigs are fond of wallowing, but differ from other animals like to wallow in that they like some shallow water over the deep mud. They used to drink water at noon, in the afternoon and late in the evening. They also used to hunt frogs and insects in the soggy grass. They do eat a variety of animal prey, but the bulk of their food is vegetarian and much of it the underground stolons, rhizomes, corms and bulbs of plants. The wild pig can dig up the ground with their snout. A groundnut field visited overnight by pig, looks as if it had been freshly ploughed up. They eat tender tall grass and root for the stolons and rhizomes of sedges and grasses.

Smell is the prime sense and sight and hearing are only fair. Sow build regular nests of tall grass for their accouchement.

13.1.1.1.2 Blyth (*Sus scrofa andamanesis*)

It is found in the forest of Port Blair, Andaman Islands and Bay of Bengal. Blyth is the wild boar found in the forests of Andaman Islands.

13.1.1.1.3 Pigmy Hog (*Sus scrofa salvanus*)

The pigmy Hog, *Sus scrofa salvanus* was first recorded in 1847 and was described by B. H. Hodgson in his paper "On a new form of Hog Kind or Suidae" in the May edition of the Journal of the Asiatic Field Society, Bengal. Hodgson stated

that it must seem almost incredible that so tiny an animal should effectually resist men. It is found in the dense, moist forests of Sikkim, Nepal, Bhutan and in parts of Assam. It is nocturnal in habit. The pig prefers to remain in high grasses and is rarely seen. It lives in herds of 15-20. The length is 66 cm from snout to rump. The weight is 7-8 kg and colour is brown-black.

The colour of the pigmy hog is blackish brown shaded unclearly with rusty red, the hairs are quite sparse in comparison of a Wild boar or a Peccary and hairs does not exceed 2.25" in length. Both the ears are short and without hair, and the jaws are shorter than those of the common Hog. The females have only three pairs of teats, i.e. half the number possessed by the domestic pigs. The young piglets are dark brown, with longitudinal rufous bands above and on the sides. The young piglets have greyish hairs about the snout, forehead, crown of head and ears. The dorsal hairs are blackish brown tinged underneath with rufous. The hairs under the throat and on the stomach were predominantly rufous. The skin has a grey pigmentation. The length from snout to base of tail for sub-adult is 18-20" with shoulder height of 8-10" weighing 7-10 lbs. The mature adult boar length measures 26" with shoulder height of 12".

Hodgson (1847) states that the pigmy hog seems to have the disposition of the peccary (*Tayassu tajacu*) as well as the resemblance. The herd consists of 5-6 to 15-20. The males fearlessly attack intruders, charging and cutting the naked legs of their human or other attackers with a speed that baffles the eyesight, and a sprit which their straight sharp laniaries renders really perplexing. The elephants, are often scared to death by the pigmy hogs, for the little creatures have tusks as sharp as razors, and gash the elephants' feet with them as they rush past them.

The pigmy hog is nocturnal, however they are most active just after dawn and some two hours before sunset. The litter consists of usually 3-4 piglets, and produce two litters a year. The gestation period of sows is 110-120 days.

The main diet of pigmy hog is roots and bulbs but also eat eggs, young birds, insects and reptiles. The Assamese local name for pigmy hog is “*Nulgahuri*”. When the area becomes water-logged, the pigmy hog go into the forested areas of the foothills. The pigmy hog’s habitat is threatened by an increasingly intensive human development.

13.1.1.2 Domesticated Pig Breeds of India

13.1.1.2.1 Ankamali Pigs

They are generally found in Southern or peninsular region i.e. Kerala, Karnataka, Tamil Nadu and Maharashtra. It is black with white patches, rusty grey in colour, is a medium sized animal weighing about 40-70 kg. The length from shoulder to vent is 0.91 M. It possess thick hair. The head and shoulder is heavier than hindquarters. Tail reaches nearly to the hock and has a tuft of hair. Female produces 12-15 piglets at a time, but survival rate is 6-8 piglet per sow.

13.1.1.2.2 Desi Pigs

It is distributed widely in Uttar Pradesh, Bihar, Madhya Pradesh and Punjab. This is the largest sized pig among the indigenous germplasm and when fully grown weighs up to 168 kg. The growth rate is very slow. The body colour varies from rusty grey to brown to black. They possess a long face tapering towards nostrils, heavy head and shoulder with lighter hind quarters. The back is slightly arched and droops towards the rump. The hair on the neck and parts of the back are bristly thick and long and those on flank and sides are comparatively thinner and shorter. The sow farrows 8-12 piglets at a time.

The Indian local or desi pigs are completely neglected and emaciated, having to find their own sustenance which consists of garbage, human excrement and some roots they may dig up. Their conformation is extremely poor.

13.1.1.2.3 Ghorī Pigs

These pigs are found in Manipur, Assam, Arunachal Pradesh, Nagaland, Mizoram, Sikkim, Bhutan and Tarai Himalayan region. In Assam and Bengla Desh they are referred as Dome pigs or pigmy pigs. It is companion of tribals. They

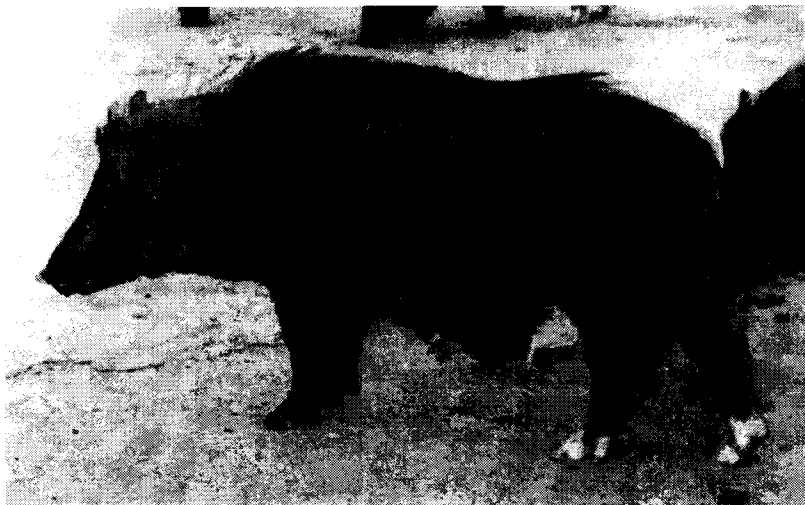


Fig. 13.1.1.2.2.1 Desi Pigs of Orissa (India)



Fig. 13.1.1.2.2.2 Desi Pig of Andaman & Nicobar Islands

are mainly black, with an admixture of light brown. There is always a row of coarse and straight bristles starting from neck to back like that of wild pigs. In the lower Himalayas, Arunachal Pradesh and Nagaland, the Ghorī pig is a status symbol and is maintained in herds of 15-30 and the farmers identify them at birth by notching. They are allowed to eat roots and other materials in specified areas.

13.1.1.3 Exotic Breeds

The primary objective of swine production is to get maximum lean meat in the form of bacon and ham. It is essential to know the different germ plasm available in the country in relation to these traits.

At present exotic breeds of pigs like Large White Yorkshire, Middle White Yorkshire, Berkshire, Landrace, Hampshire, Tamworth, Wessex Saddleback, Duroc are being maintained at 158 Government Pig Breeding Farms of India.

The characteristics of important exotic breeds are as follows:-

13.1.1.3.1 Large White Yorkshire

The Large White Yorkshire is a native breed of United Kingdom and is reported to produce better bacon when crossed with other suitable types. This breed is imported into India from UK, New Zealand and Australia. Mature boars and sows of this breed generally weigh 295-408 kg and 227-317 kg respectively. This breed is very popular for the bacon.

13.1.1.3.2 Middle White Yorkshire

The Middle White Yorkshire was evolved as a result of crossing Large White Yorkshire and Small White Yorkshire breeds of UK. It is a medium sized bacon pig and a good porker as light weights. Mature boars and sows of this breed generally weigh 249-340 kg and 181-272 kg respectively.

13.1.1.3.3 Berkshire

The Berkshire is one of the oldest English breed of swine. This breed is valued as producer of quality meat, specially suitable for the pork market. Mature boars weigh about 280-360 kg or more.

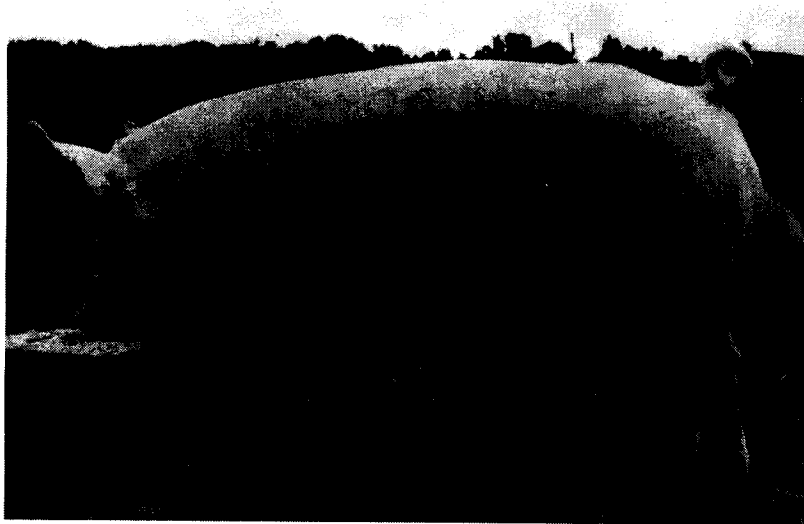


Fig. 13.1.1.3.1.1 Large White Yorkshire Boar



Fig. 13.1.1.3.1.2 Large White Yorkshire Sow



Fig. 13.1.1.3.5.1 A Hampshire Boar

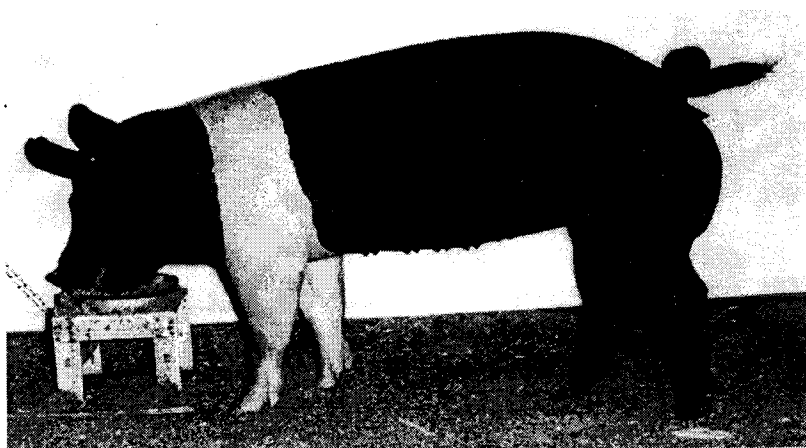


Fig. 13.1.1.3.5.2 A Hampshire Gilt

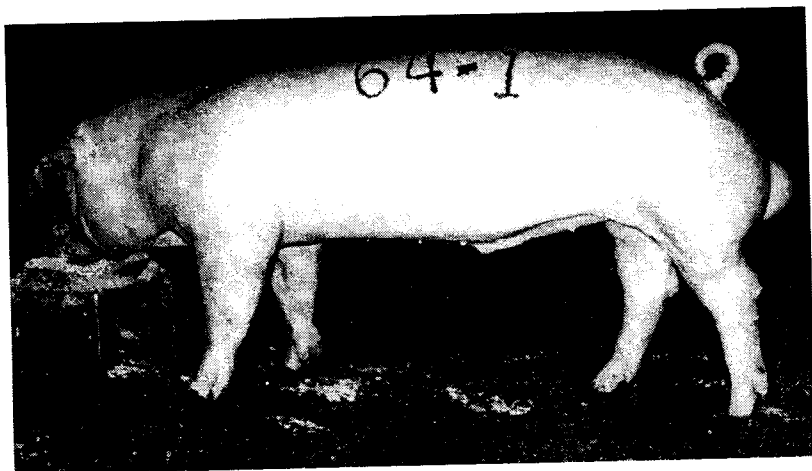
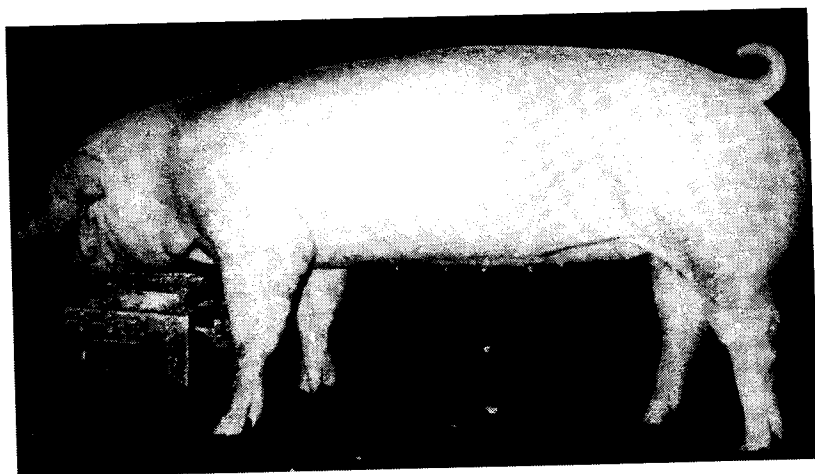


Fig. 13.1.1.3.4.1 A Landrace Boar



ig. 13.1.1.3.4.2 A Landrace Gilt



Fig.13.1.1.3.8.1 A Duroc Boar

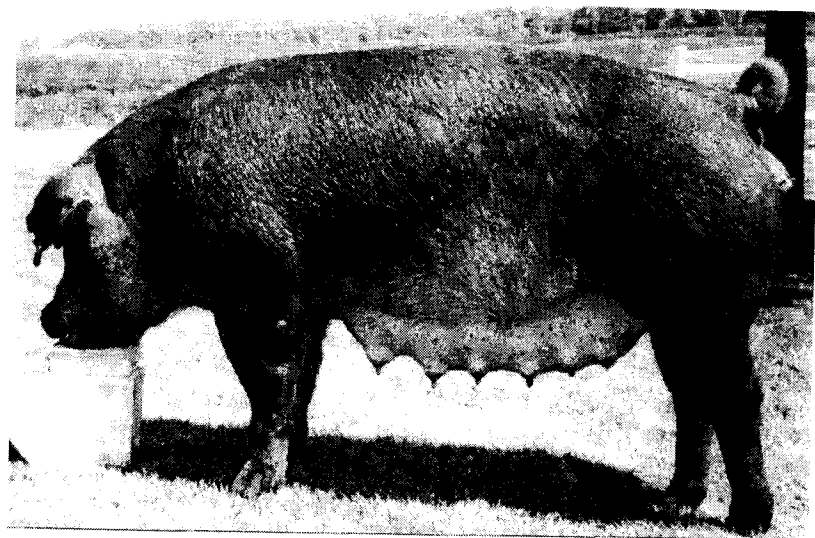


Fig.13.1.1.3.8.2 A Duroc Sow

13.1.1.3.4 Landrace

Landrace pig is an excellent bacon yielder. It is a native of Denmark. It was imported into Britain in 1949 and is the second popular breed in UK. Danish Landrace with long barrel is very famous bacon breed. The pigs proved to be superior to Large White Yorkshire in carcass quality. Boars of 25 weeks of age weigh 95.5 kg.

13.1.1.3.5 Hampshire

Hampshire breed was developed in U.S.A. from hogs imported from UK. It is a black hog with a white belt encircling the body and including the front legs. The weight of a mature boar is 300 kg and sow 280 kg.

13.1.1.3.6 Tamworth

Tamworth is possibly the purest modern representative of the native English pig. The colour is reddish or chestnut, typically golden red hairs on a flesh coloured skin. The carcass produces of bacon of best quality. Mature boars weigh up to 300 kg.

13.1.1.3.7 Wessex Saddleback

Wessex Saddleback, an English breed is essentially a bacon breed, easily adaptable for pork production. It is known for its prolificacy and has a robust make up. Head, neck, hind quarters, hind legs and tail of this breed are black. Head is fairly long with straight snout and ears having a forward pitch without being floppy. Pigs of 8 weeks of age weigh 21.5 kg.

13.1.1.3.8 Duroc

Duroc has its origin in U.S.A. It is red in colour, with the shades varying from a golden to very dark red. The weight of mature boar is 410 kg and sow 250 kg.

13.2 Pig Breeds of the World

The country wise important pig breeds of the World are as follows:-

BELGIUM

Belgian Landrace

It is characterized by an appearance and characteristics that distinguished it more and more sharply other European types of Landrace. Most Belgian farmers raise Landrace only and it is



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also used to get the crossbred and hybrid pigs with Pietrain.

Pietrain

The difficult state of the market in 1950-51 brought to the fore a local breed called after the village where was first obtained, Pietrain. This breed soon won a prominent place for itself in Belgian production. It also quickly acquired a European reputation for its black spotted coat, for its build, stockier and distinctly broader than that of most known breeds, but especially for its unprecedented meatiness, pure-muscle with almost no fat.

This breed is of medium size and is white with black spots. Around the black spots there are characteristic rings of the light pigmentation that carries white hairs. These markings are known as piebald markings. The ears are erect..

Pietrain boars are useful for crossing with Belgian Landrace sows. The sows are highly prolific but they lack in mothering ability and milk production. Pietrain swine were imported into Germany in 1960-61. They are commonly used in cross-breeding in Germany to improve the quality of pork produced. In Belgium, this breed is tested regularly for the selection of superior performing lines of swine in the 8 test stations.

CANADA

Lacombe

It is the fifth ranking breed of swine in Canada. The breed is medium sized, white has large drooping ears. Its body is long, legs are shorter and quite meaty in confirmation. This breed is known for its rapidity of weight gain and docility. It was first registered in 1957. Sows and boars are highly fertile. The cross-bred sows are excellent in performance.

CHINA

There are 121 breeds of pigs in China and over recent years, China probably has created more new breeds of pigs than any other country. The large number of breeds of pigs are due to the long history of the domestication of pigs as early as about 10000 years ago and topographic complexity, marked climatic variability and differing requirements such as lard, pork, salted

pork, ham etc., by the people in various parts of the country. The number of pigs in China was 468 million at the end of 1997 (FAO, 1998), and the country takes first place in the World (Table 5.4.1).

On the basis of topographic and ecological conditions, pig breeds in China are divided into the 6 regional types namely: North China, Central China, Lower Changjiang River Basin, South China, Southwest China and Plateau.

Fengjing

The Fengjing pigs are Taihu pigs because the Taihu lake is in their region of origin. This area lies in Lower Changjiang River Basin.

The colour of the breed is black with wrinkled face and skin. Sows grow to about 69 cm high, 98 cm around the chest and 69.6 kg in live weight. These pigs reach puberty at 2.5 months to 3 months of age. This breed is among some of the most prolific breeds of the World. The average litter size at birth is 15.8 piglets and at weaning 13.3 piglets with 2 litters per year. The sows have 9 pairs of teats.

Hezuo

It is located in the Gannan Tibetan Autonomous Prefecture of Gansu Province, where the altitude is 2600 m high and the annual mean low temperature is 1.7° C. The pigs are out on pasture all year round, and are characterized by long, coarse and dense bristles, a slow growth rate and low prolificacy, with a litter size of 4 to 7. Females have 5 pairs of teats.

Jiaxing

It is found in Lower Changjiang River Basin, where the average lowest temperature is -9.1° C and average highest temperature is 38.2° C. The body colour is black, and mature sows height is 68.3 cm, with heart girth 93 cm. Mature sows weigh 61.3 kg. Females attain sexual maturity at the age of 2.5 months. It is highly prolific with litter size of 17.5 at birth. Females have 8-9 pairs of teats.

Jinhua

The Jinhua pig of Zhejiang Province in China is

characterized by its white body, with black at the head and rump and tail. It is also known as “*two-end-black*” breed. The back and loins are slightly curved. The breed is known for its thin skin, fine bones and tender meat. It belongs to Central China, where the climate is temperate and moist. Jinhua pigs are known for early maturity and may be mated as early as 3-4 months old. They are fairly prolific with an average litter size of 11.9 at birth and 11.3 at weaning and have 7-8 pairs of teats.

Kele

The kele is located in Southwest China in the Yunnan-Guizhou mountainous areas where the altitude is between 1700 to 2400 m. They withstand in erratic changes in weather. They are characterized by arched back and loin, long straight snout, narrow chest, wrinkled hind legs, strong feet, light body. Sows are low in prolificacy, as the litter size at birth is 8.7 piglets. The females have 5-6 pairs of teats and attain sexual maturity at 3-4 months of age. The colour of the pigs is black and sows grow 54 cm high, heart girth 92 cm and live-weight of 63.2 kg. The backfat thickness varies from 5.1 to 7.2 cm and dressing percentage is 74.5%.

Large Black-White

it is found in Zhujiang River Delta in Guangdong province of Central China region. The colour of the coat is white-black patched. It has a slightly concave back and pendulous, drooping belly. This breed is precocious, with its first mating at 3-4 months old. It is highly prolific with a litter size of 13. The females have 7 pairs of teats. The mature sows height is 60.4 cm, heart girth 110 cm and weigh 68.1 kg.

Luchuan

It is found in Guangxi Zhuang Autonomous Region in the South China. The colour of the body coat is black at head and back. The back is concave and belly is pendulous touching the ground. The back fat is thick i.e. 4-6 cm. Females attain sexual maturity at the age of 4 months. The average litter size is 11.5 at birth. Females have 6-7 pairs of teats.



Fig. 13.2.1 Highly prolific Meishan Pigs

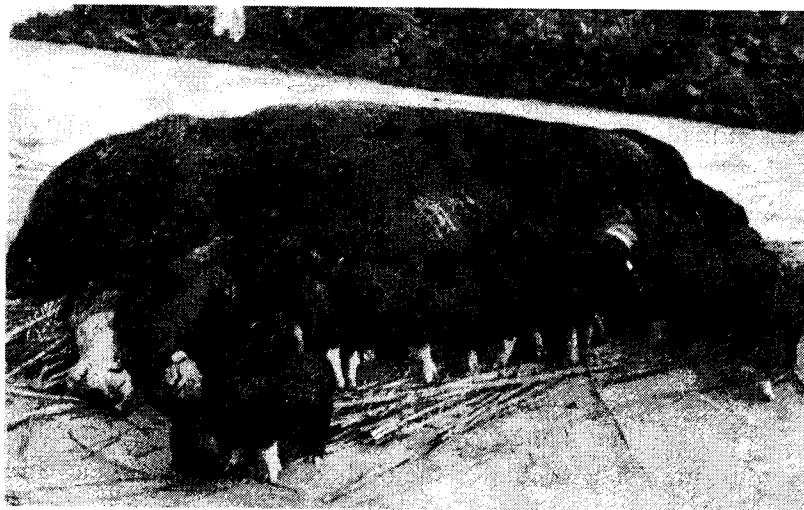


Fig. 13.2.2 A Chinese sow with her piglets

Meishan

This breed belongs to the Lower Changjiang river Basin of China. They are also considered Taihu pigs, deriving their name from the Taihu Lake in their region of origin.

This breed is considered to be resistant to some diseases and are able to consume large amount of roughage. The face is wrinkled face and skin is also wrinkled. Sows grow to about 57.8 cm high and heart girth 100 cm and 61.6 kg live weight. The colour of the breed is black with white feet. The backfat thickness is 2.5 cm and dressing percentage is 66.8%. The gilts reaches to sexual maturity in 2.5 months. The average litter size in sows is 14.3 piglets at birth and 13.3 piglets at weaning. The sows have 8-9 pairs of teats (Fig.13.2.1).

Ming

The Ming breed of pigs belongs to North China. They are also known as “Minzhu” or “Min” or “Da Min”. Minzhu is said to mean “folk pig”. These pigs are tolerant to cold temperatures and harsh feeding conditions. This breed can be raised with roughage with limited concentrates.

It has long black hair. This hair has coarse, long bristles and a dense woolen under coat in the winter. This hair allows sows to farrow in an open shed at 4° C with ease. The body size is relatively large, with a narrow, level back and loin. These are able to store 4.6 kg of body fat in the abdomen. Sows grow to about 87.5 cm high, 130 cm around the chest, and 88.3 kg in live-weight. They have a backfat thickness of 3.2 cm and dressing percentage of 72.2%. The females have 7 pairs of teats and reaches to sexual maturity in 3-4 months. The average litter size is 12 piglets at birth and 11.3 piglets at weaning.

Neijiang

It is found in Sichuan basin of Southwest China, where the climate is mild and agriculture is well developed, and the area is rich in feed supplies. The pigs are comparatively large in size with strong body constitution. Mature sows height is 61 cm, heart girth 104 cm and weigh 90.2 kg. The body coat is black in colour. The boar attain sexual maturity at the age of 2 months.

Sows attain sexual maturity at 3-4 months of age. The average litter size is 10.6. Females have 7 pairs of teats.

Ninxiang

This breed is of the Central China and originated in the Hunan Province of China in the Central Subtropical belt. The breed is normally housed and hand-fed year round. The hair coat pattern is white body with black neck and silver ring around the neck. The back is slightly concave, and the belly is pouched and pendulous. The sows grow 61.6 cm high, 114 cm in Heart girth and 70.6 kg in live-weight. The backfat thickness is 4 cm thick and the average dressing percentage is 70. The gilts reaches to sexual maturity at 3 months of age. The litter size is 11.5 piglets at birth and females have 7 pairs of teats.

Shenxian

It is found in North China region. The colour of the pigs is black and mature sow height is 60.1 cm, heart girth 109 cm. Mature females weigh 75 kg. It is located in the Middle temperate belt, where the climate is dry and cold. The annual lowest temperature is -22.5°C, while the highest temperature is 42.7°C. They can generally withstand cold weather and harsh feeding conditions. Females mature at 3.3 months of age and litter size is 12. Females have 8 pairs of teats.

South Yunnan Small-ear

It is found in Yunnan Province in the North Tropic Belt. Its body colour is black with average height in sows is 59.6 cm, heart girth 105 cm. Mature sows weigh 63.4 kg. Females mature at 2-3 months of age and can be bred at the age of 3-4 months. The pigs are less prolific with a litter size of 8 to 11. Females have only 5-6 pairs of teats.

Tibetan

It is found on the Qinghai-Tibet Plateau, which is located at an altitude of 4000 m. It is especially adapted to the high, cold climate and to bring on pasture all year around. It is characterized by light weight i.e. 35 kg in mature animals, alertness in running and jumping, with quick responses for guarding against attack from other animals. It has narrow head

and straight snout to facilitate searching for feeds under the ground. The hair coat is black with long and dense bristles. The bristles are 2-3 times longer than other breeds i.e. 12 cm long. The density of bristles is 71/cm², which is approximately three times as dense as in Sichuan native pigs, which protect it from the strong solar radiation of ultra-violet rays and also from the cold weather on the Plateau. The average temperature in cold weather varies from -20° to -30° C. It can utilize shrubs, stems, roots and hard seeds of wild plants. The ability to deposit fat in the body is 15% of body weight. The prolificacy is low with a litter size of 5. Females have 5 pairs of teats.

Wenchang

It is found in South China. The colour of the body coat is white with black at back. It is characterized by a low-set, concave back, a pouched, pendulous belly touching the ground. The back fat thickness is very thick, i.e. 7 cm. Mature sows height is 47.2 cm, heart girth 91 cm and weigh 62 kg. The females attain sexual maturity at the age of 4 months. The litter size is 8-10 at birth. Females have 6-7 pairs of teats.

DENMARK

Danish Landrace

Danish Landrace is a medium to large breed that has a distinct physical appearance. They are white in colour, have a fine hair coat, long snouts and heavy drooping ears. They have long bodies having deep smooth sides, and a noticeable lack of excess fat and wrinkles. The first registered herd was established in 1896.

The breeding of seed stock for this breed in Denmark is carried out on a national scale in herds registered, supervised and approved by the National Committee for Pig Breeding and Production. The average daily gain is 764 grams with feed conversion ratio 1.3 kg, the percent of meat in the carcass is also very high i.e. 64.7%. It is a long and lean breed known for its very high fertility and excellent motherhood.

GERMANY

German Landrace

This breed was originated in 1900 in Northwest Germany and especially in Lower Saxony. The colour is white and the ears are heavy with the characteristic droop. Other characteristics are similar to other Landrace breeds. The sows have excellent fertility, heavy milking and good mothering ability.

German Landrace have proven very useful in cross-breeding and in improving the general performance of pigs in Germany and about 1000 pigs are exported each year to other countries.

German Pasture Pig

It is also known as Hannoverian-Brunswick. It is characterized by black and white colour and the wooly-haired Mangalitza pigs which are mostly native to Hungary and are considered to be under severe threat of extinction.

HUNGARY

Mangalitza

This is a native of Hungary and characterized by wooly hair coat. The color is white to dull white.

INDIA

Ankamali Pigs

They are generally found in Southern or peninsular region i.e. Kerala, Karnataka, Tamil Nadu and Maharashtra. It is black with white patches, rusty grey in colour, is a medium sized animal weighing about 40-70 kg. The length from shoulder to vent is 0.91 M. It possess thick hair. The head and shoulder is heavier than hindquarters. Tail reaches nearly to the hock and has a tuft of hair. Female produces 12-15 piglets at a time, but survival rate is 6-8 piglet per sow.

Desi Pigs

It is distributed widely in Uttar Pradesh, Bihar, Madhya Pradesh and Punjab. This is the largest sized pig among the indigenous germplasm and when fully grown weighs up to 168 kg. The growth rate is very slow. The body colour varies from rusty grey to brown to black. They possess a long face tapering



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towards nostrils, heavy head and shoulder with lighter hind quarters. The back is slightly arched and droops towards the rump. The hair on the neck and parts of the back are bristly thick and long and those on flank and sides are comparatively thinner and shorter. The sow farrows 8-12 piglets at a time.

Ghori Pigs

These pigs are found in Manipur, Assam, Arunachal Pradesh, Nagaland, Mizoram, Sikkim, Bhutan and Tarai Himalayan region. In Assam and Bengla Desh they are referred as Dome pigs or pigmy pigs. It is companion of tribals. They are mainly black, with an admixture of light brown. There is always a row of coarse and straight bristles starting from neck to back like that of wild pigs. In the lower Himalayas, Arunachal Pradesh and Nagaland, the Ghori pig is a status symbol and is maintained in herds of 15-30 and the farmers identify them at birth by notching. They are allowed to eat roots and other materials in specified areas.

ITALY

Italian Landrace

It has become dominant as an improved breed in Italy. They have the large drooped ears and white coat that characterizes the appearance of other Landrace strains. They have been effective in improving the productivity and quality of swine in Italy as they have bred with other breeds and the local swine. They are highly prolific, high milk producing and have good mothering ability to mother large litter to weaning.

MEXICO

Cunio

This is a miniature pig of the highlands of Mexico. This is a remarkable though nearly extinct breed group, which was very popular some 60 years ago in most of the maize growing districts of the highlands of Mexico.

Mature pigs weighing no more than 12 kg and females up to 10 kg have been recorded. The colour of the Cunio pig varies from black, spotted and yellow. The litter size is also very small, i.e. 2-3 piglets per litter.

Mexican Wattled

This is a native Mexican pigs with wattles, weighing no more than 60 kg when fully grown. They are quite variable in colour, i.e. red, black, spotted. They are characterized by two small wattles under the chin, with one often longer than other. The common Mexican name for this pig is *Cerdo coscate*. They have very strong legs and back, and are well adopted to living in dry areas where they have to walk more than a mile a day to find their living.

NETHERLANDS

Dutch Landrace

The breed originated from the original native pig with infusions of German Landrace and the Danish Landrace. The breed is found in the southern, eastern and northern parts of the country.

It is similar in appearance of the other Landrace breeds. It is white in colour with large and droopy ears. This breed is known for high fertility and very good mothering ability.

NORWAY

Norwegian Landrace

It is the leading breed of swine in Norway. It is mostly raised in the southern part of the country and most are found in the area of Hamar. They are white in colour and have a heavy drooped ear. The breed originated from importations of Landrace from other countries having the breed. There was then special selection to give the blend of introduced strains a unique adaptation to the environment of Southern Norway.

SLOVENIA

Krskopolje Saddleback

It is the only Slovene autonomous pig breed and was found in the Carniola and Styria regions of Slovenia. The back part of the body is usually black, while the front part is more or less white- in the form of a wide white stripe or belt around the body. The head is of medium-length and flat, with big, hanging ears. The breed is characterized by an average good fertility, a good appetite, growth ability and large adult weight. The adult

animals weighs up to 250-300 kg. The gilts farrow at the age of 13 months and the litter size at birth is 8.78 piglets and 7.28 piglets at weaning.

SWEDEN

Swedish Landrace

It is the leading breed of swine in Sweden. It is characterized by heavy drooping ears, white colour and high proportion of lean meat. The breed also possess a satisfactory rate of gain, feed conversion efficiency, prolificacy and the mothering ability.

SWITZERLAND

Shallow-Belted Mangalita

It is also known as Wollschwein (German). The homeland of this breed was the former Austria-Hungary. It is robust, resistant to diseases and stress and of a balanced disposition. Powerful legs and strong hooves allow it to securely move about in any landscape. The thick, bristly coat protects in all kinds of weather. The pigs prefer wallowing for cooling and care for the skin. It is suited for extensive pork production.

UNITED KINGDOM

Berkshire

The Berkshire is one of the oldest English breed of swine. This breed was first registered in 1884. This breed is valued as producer of quality meat, specially suitable for the pork market. This breed is used in upgrading programs. The pigs are black with white markings usually on the feet, head and tail. It has a short head with dished face. The snout is short. The body is long and ribs well sprung. Mature boars weigh about 280-360 kg or more.

British Landrace

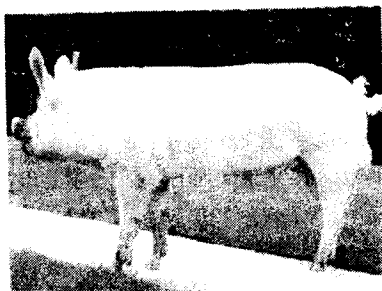
Landrace pig is white with lop ears, has a long side with good hams and is an excellent bacon yielder. It is a native of Denmark. It was imported into Britain in 1949 and is the second popular breed in UK. The pigs proved to be superior to Large White Yorkshire in carcass quality. Boars of 25 weeks of age weigh 95.5 kg.



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British Saddleback

The dual purpose breed was formed in 1968 by the amalgamation of the Essex and Wessex Saddleback breeds, whose respective breed societies dated from 1918.

They have black hair with a white band running over the shoulders and down the forelegs. It is known for its prolificacy and has a robust make up. Head, neck, hind quarters, hind legs and tail of this breed are black. Head is fairly long with straight snout and ears having a forward pitch without being floppy. Pigs of 8 weeks of age weigh 21.5 kg.

The Gloucester Old Spots

It is native to the region embracing North Somerset, Gloucester, and part of Wiltshire. It is a large size breed, the ears are lax but slightly shorter than those of the Large Black, with the tips hanging rather wider apart. The colour is spotted—clearly defined spots of black on white skin and hair. It is adapted for outdoor feeding where grass forms a large proportion of the food. It is hardy and prolific and suitable for pork and heavy hog production.

Large Black

This breed was first registered in 1899. It was a native of Devon and Cornwall and Suffolk and Essex. It is slightly inferior in size and length of the body is smaller than Large White. The ears are long and lax, with the points hanging close together and level with the tip of the nose. The colour is uniform jet black. The breed is highly prolific and hardy and docile. The sows have very good mothering ability and high litter size. The breed is well adapted for outdoor system, grazing freely and taking moderate exercise.

Large Blacks are large, just slightly smaller than Yorkshires, and always black. They have long heads and straight faces, with lop ears. They have a good depth of body, fair length and strong backs. The hair is fine and rather thick with the black pigmentation during quite heavy. They are characterized by heavy drooped ear, the ears are so large they cover much of the face and seem to obstruct the view from the eyes. This breed is

known for very docile nature, high levels of hardiness and thriftiness, with light shoulders, and good sides and hams.

Large White

The Large White is a native breed of United Kingdom and is reported to produce better bacon when crossed with other suitable types. This breed was first registered in 1884. Virtually every country in the World that values swine has made importations of the Large White.

It is large in size with a long and slightly dished face. Body is covered with fine hair, free from curls. Skin is pink colored and is free from wrinkles with long and moderately fine coat. Ears thick, long and slightly inclined forward and fringed with fine hair. Neck is long and full to the shoulder with deep and wide chest. Shoulders are not too wide. Back is slightly arched, loin is long and broad with a well developed wide rump. Hump is fleshy extending up to the hocks. Tail is set high. Mature boars and sows of this breed generally weigh 295-408 kg and 227-317 kg respectively. This breed is very popular for the bacon.

It is also known for large litters, heavy milk production and having excellent maternal instincts. It is regarded as a rugged and hardy breed that can withstand variations in climate and other environmental factors.

Middle White

The Middle White Yorkshire was evolved as a result of crossing Large White Yorkshire and Small White Yorkshire breeds of UK. It is a medium sized bacon pig and a good porker as light weights.

It is white in colour with a short head un-turned dished face wide between the ears. Neck is blended neatly from head to shoulder. Ears are nearly erect but somewhat inclined forwards. Hams are broad and fleshy up to the hocks. It is a prolific breeder, maturing early and the sows make good mother. Mature boars and sows of this breed generally weigh 249-340 kg and 181-272 kg respectively.

Tamworth

Tamworth is possibly the purest modern representative of the native English pig. The breed was first registered in 1884. The colour is reddish or chestnut, typically golden red hairs on a flesh coloured skin. The snout is very long is straight. The ears are fairly large and rigid and incline forward. It has a strong back and thin shoulders. The carcass produces of bacon of best quality. Sows are prolific breeders. Mature boars weigh up to 300 kg.

Welsh

It is the third ranking breed of swine in Britain. Welsh swine are a droop or lop-eared white breed with slightly dished faces. They have shorter legs than most other popular breeds, but have very long bodies. They are also quite muscular and lean. They are characterized by their ability to thrive under farm conditions, good sized litters, fine mothering instincts and desirable carcass characteristics. The litter size of sows at birth is 9.75 piglets, but known for general adaptability, good gain performance and high carcass quality.

UNITED STATES OF AMERICA

American Berkshire

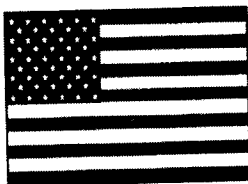
The American Berkshire breed claims the oldest lineage of all the popular breeds of swine in America. It originated in England and takes its name from Berkshire, a country in south central England, which was the center of its development. Berkshire are believed to have been first introduced into the United States in 1823 by John Brentnall, an English farmer who had settled in New Jersey. These are medium sized, somewhat longer in proportion to depth than other breeds and shorter of leg. The colour is black with "six white points", white on feet, nose and tail. The ears are erect, nose is short and face is slightly dished.

American Yorkshire

These pigs are productive, leaner and more durable. The goal of the Yorkshire breed is to be the source of durable mother lines that can contribute to longevity and carcass merit. The American Yorkshire Club and it's members plan to be a part of

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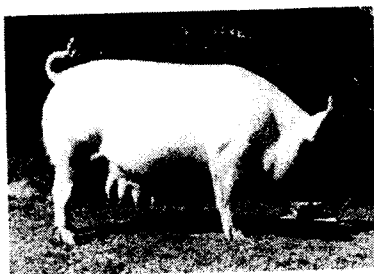
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Chester White

The Chester White breed originated in Chester Country, Pennsylvania. The National chester white record association was formed in 1893, with offices in West Chester, Pennsylvania.

Sow's mothering ability is very good, and pigs are sturdy and these pigs are still popular with numerous pork producers.

The body coat is pink in color with white hairs. The sows are prolific, usually milk well and make excellent mothers.

Duroc

The Duroc had its origin in the Eastern United States and in the corn belt. The colour varies from a very light golden, almost yellow colour, to a very dark red that approaches mahogany. It has a medium length and face is slightly dished. The ears are drooping and not erect. It is a large breed with excellent feeding capacity and prolificacy. The sows are good mother. The weight of mature boar is 410 kg and sow 250 kg.

Guinea Hog

Guinea Hog or Guinea Forest hogs, originated from the Guinea coast of Africa and were spread widely through the slave trade from Africa to England, France, Spain and America. Historically, Guinea hogs were large and square, with reddish bristly hair, a long tail, and pointed ears. They were hardy grazers and foragers that could be raised on pasture and still produce both lard and pork. Their numbers declined drastically with the collapse of the lard market and the shift away from backyard pork production.

Today's Guinea hogs are small, only 10-30 lbs and 15-20 inches tall when fully grown. They are usually black and often hairy. Guinea hogs are very gentle and easy to care for, making them popular at children's zoos, though they remain suitable for small scale pork production.

Hampshire

Hampshire breed was developed in U.S.A. from hogs imported from UK. It is a black hog with a white belt encircling the body and including the front legs. Head and tail are black,

and the ears are erect. The pigs are short legged. Sows are very prolific breeders. The weight of a mature boar is 300 kg and sow 280 kg.

Hereford

The pigs have white face, not less than two-thirds red exclusive of face and ears, with at least two white feet- white showing not less than one inch above the hoof. They are also red in colour, either light or dark red. The shade of red may vary from light to dark, but a deep colour is preferred. The hog has a medium length of face with a slight dish and carries a drooping ear of at least medium size. The sows are prolific and good mothers. The hogs are fair grazers, good feeders and they fatten readily.

Mulefoot Hog

The most distinctive feature of the American Mulefoot hog is the solid hoof which resembles that of a mule. Pigs with solid hooves have attracted the interest of many writers over the centuries, including Aristotle and Darwin.

They are mainly black, with occasional animals having white points, medium flop ears and soft hair coat. The hogs are of fairly gentle disposition, fattened quite easily and weighed from 400 to 600 lbs at two years of age.

Ossabaw Island

The hogs of Ossabaw island, off the coast of Georgia, are descendants of Spanish pigs brought to the New World over 400 years ago. They were small range pigs with prick ears, heavy coats and long snouts. As the pigs adapted to Ossabaw Island, they became yet smaller by adopting the food cycle on the island, which provides little to eat during the spring season. They are able to store large quantities of fat than any other hog. The pregnant sows are weighing less than 100 lbs. The colour of the coat varies from black, spotted black and white, red and tan. The hogs grow much larger in captivity. Their population is classified as Endangered in World Watch List for Domestic Animal Diversity (1995).

Poland China

It has its origin in USA. It is black in colour with white spots. The average litter size at birth is 7.98 pigs, but the rate of gain is below average and carcass is suitable for good heavy ham.

Spotted

They are known for their ability to transmit their fast-gaining, feed efficient, gentleness and durability.

Tamworth

The first Tamworths were brought to the United States in 1882 by Thomas Bennett of Rossville, Illinois. Tamworth are very deep-sided hogs and are uniform in their depth of side. They carry a strong, uniform arch of back, and while not as wide of back as hogs of the thicker breeds. They do have a very muscular top and a long rump. It is characterized by comparatively long of neck, long of leg and lacks in width of body. The snout is moderately long and quite straight. When seen from the side, the face usually has a very slight suggestion of a dish. The ears are of medium size and erect. The colour varies from golden red to a dark red. It is a rugged, thrifty, very active breed of swine .

ENEZUELA

Venezuelian Black

This is a strong, tall breed kept in the more fertile lands of the Llanos of southern Venezuela and Colombia. These pigs are remarkable for their ability to live a semi-feral life, since they are not kept in households but live by themselves, digging up roots of grasses and reeds, succulent tubers or rhizomes in the more sandy parts of the Llanos. Sows farrow about once a year. Most of the males are castrated and turned black with the herd until the following year when they are sent to market with weights often surpassing 90 kg. They are practically feral and defends themselves from attacks of jaguars.

13.3 Productivity of Desi Pig Breed

In India the reasons for the low productivity are manifold. The low production potential of the genotypes of indigenous

breeds has been identified as one of the major causes. Therefore, programs aimed at improving the genotypes are of paramount importance in increasing the productivity of pig population in India. The production potential of indigenous genotype is very low, but they are well adapted to the different production systems.

Productivity of Desi Pigs as observed by NCA(1976)

Traits	Performance of Desi Pigs(Av.)
Litter size at birth	7.52 piglets
birth weight (kg)	0.91
Weaning weight at 56 days	4.15 kg
Weaning percentage	54%

13.4 Productivity of Exotic Breeds in India

The productivity of exotic pigs in Indian conditions has been evaluated by AICRP on pigs. In order to raise the productivity of indigenous pig stock and thereby to obtain better meat yield, high quality breeds are imported from foreign countries such as UK, U.S.A., New Zealand and Australia.

Productivity of Exotic Pigs as observed by NCA(1976)

Traits	Performance of Exotic Pigs(Av.)
Litter size at birth	10.44 piglets
birth weight (kg)	1.40
Weaning weight at 56 days	13.57 kg
Weaning percentage	78.5%

The primary objective of swine production is to get maximum lean meat in the form of bacon and ham. It is essential to know the different germ plasm available in the country and all over world in relation to these traits.

13.5 Productivity of Exotic Pigs in Foreign Countries

The productivity of exotic breeds of pigs is significantly higher than Indian breed. The productivity of some of the important exotic breeds is being published by the Breed Associations of various breeds on annual basis.

13.6 Gap of Productivity of Pigs

There is a significant gap between the productivity of Indian pigs and exotic pigs. The indigenous pigs in general attain a body weight of 30 to 45 kg at 18 months of age. However,

preferred marketable body weight of 70-80 kg is attained by the present day improved exotic varieties of pigs in about 5-6 months of age in countries with well developed pig industry.

13.7 Breeding Recommendations by NCA

Comments of National Commission on Agriculture (1976)

32.1.29 Pig development has a special significance in the north eastern hilly regions. Pork and Pork Products are popular in the north eastern States. Consumption of pork is very high. We are very pleased to learn that the Central Government is taking up a very comprehensive piggery development programme for the north eastern States with the help of Danish International Development Agency. As has been envisaged under this programme, a regional pig breeding station of 200 sows capacity will be established at Shillong and there will be 7 sub-units for all other north eastern states and one sub-unit for Assam Agricultural University. Each of the sub-units will have 30 breedable sows. A pig slaughter house having capacity of handling 20 pigs a day will be attached to the Regional Pig Breeding Station.

32.1.30 We are of the view that the Central Government have taken up a right decision for intensifying pig production in the north- eastern states. Intensification of pig production will be timely action to bring about a balance between supply and demand for pork. The scheme should be implemented expeditiously.

Summary of Recommendations made by NCA (1976)

7. Immediate steps should be taken to remove the constraints standing in the way of undertaking suitable pig breeding programmes in the Regional Pig Breeding Stations and the Pig Breeding Farms/ Units near the bacon factories.
11. The nucleus breeding herd in the Regional Pig Breeding Stations should be strengthened.
12. Considerably more exotic pigs are required to be imported for undertaking selective breeding programme on scientific lines in Regional Station.
14. For some of the north-eastern states breeds like Berkshire, Hampshire, Saddleback or Poland China should be selected for breeding as the people in these areas prefer black coloured pigs.
17. A co-ordinating cell should be created for proper execution of the Co-ordinated Pig Breeding Programme.
19. Agricultural Universities should undertake studies on pig

breeding with indigenous and exotic breeds of pigs.

20. The programme for pig development in the North-eastern states should be implemented soon.

13.8 Pig Breeding Policy of India

There is no pig breeding policy in India. There is an urgent need to frame pig breeding policy based on agro-climatic condition, consumer preference and productivity of pigs.

13.9 Pig Breeding in North-Eastern States

The pig has a special attraction and significance in the north eastern region and on average a pig is being reared by a family in this area. Breeding pigs are being maintained at 88 Government Pig breeding farms in North-eastern region.

All India Co-ordinated Research Project on Pigs

The Indian Council of Agricultural Research (ICAR) initiated an All India Co-ordinated Research Project on Pigs during the Fourth Five Year Plan. The Project sanctioned in October, 1970 started functioning early in 1971. The major objective of the project is to develop suitable breed of pigs using imported stock. One of the 4 centres is functioning in North-eastern states, i.e. in Assam Agricultural University, Khanapada, Assam.

13.10 Cross-bred/ Exotic Population of India

As per the Indian Livestock Census, 1992 the Assam has the highest population of pigs, i.e. 1364,000, followed by Manipur (383,000), Meghalaya (294,000), Arunachal Pradesh (239,000), Tripura (188,000), Mizoram (112,000) and Sikkim (44,000). Assam alone has recorded 10.66% of pigs of India, as per 1992 census. The rate of growth in 1992 over 1997, was highest in Tripura (113.64%), followed by Assam (112.79%), Sikkim (41.94%), Mizoram (36.59%) and Meghalaya (5%). The growth rate was negative (-1.65%) in Arunachal Pradesh and no growth was recorded in Manipur.

13.11 Grant-in-aid for Import of Breeding Pigs

During VIII Plan GOI had provided Rs. 851 Lakhs as Grant-in-aid under scheme "Assistance to States- for Integrated Piggery Development". During 1991-92 GOI had sanctioned Rs.3.00

lakhs to Arunachal Pradesh, Rs.3.00 Lakhs to Assam, Rs. 3.00 Lakhs to Mizoram, and Rs. 3.00 lakhs to Sikkim, which amounts to 34% of the total grant of India, i.e. Rs.35.00 lakhs.

Import of Exotic Pigs for Breeding

During 1997-98, 89 Large White Pigs were imported from U.S.A. for breeding at Government Pig Breeding Farms of Mizoram and during 1999-2000 total 300 exotic pigs for various state governments were imported from USA. under centrally sponsored scheme "Assistance to States for Integrated Piggery Development".

13.12 Pig Genetic Resources

Animal genetic resources include all species, breeds and strains that are of economic, scientific and cultural interest to humankind for agriculture both present and in the future. Animal domestication began some 12000 years ago when people began selecting animals for food, fiber, work power and manure.

13.13 Pig Genetic Diversity

It allows farmers to select stocks or develop new breeds in response to changes in the environment, threats of disease, new knowledge of human nutrition requirement, changing market conditions and societal needs, all of which are largely unpredictable. Indigenous pigs and wild pigs often possess valuable traits such as disease resistance, high fertility, good maternal qualities, unique product qualities, longevity and adaptation to harsh conditions and poor quality feed, all desirable qualities for low-input, sustainable pig husbandry.

The Thaihu pigs of China, for instance, offer valuable traits for swine breeders worldwide. This group of pigs have thick, wrinkled skin and long, droopy ears. They can use a high proportion of forage foods in their diet. The adult pig has little lean meat. But Thaihu pigs reach sexual maturity in just 64 days, are extraordinary fertile producing an average litter of 16 piglets compared to only 10 for Western breeds, and produce juicy, tasty meat.

13.14 Popular Modern Breeds of Swine

The breed characteristics of important exotic breeds of the

World are as follows:-

Breed	Origin	Colour	Litter size
Hampshire	USA	Black, white belt	8.66
Duroc	USA	Red	9.78
Poland China	USA	Black, white spot	7.98
Spotted	USA	Black, white spotted	8.7
Chester white	USA	White	9.33
Large White Yorkshire	UK	White	10.75
Berkshire	UK	Black, white	7.74
Tamworth	UK	Red	7.42
American Landrace	Denmark	White	9.74
Local	India	Black	6.0

13.15 Productivity of Imported Exotic Breeds

The productivity of imported/ exotic breeds in existing environmental condition have gained importance in recent years.

In recent times, the pig breeds have been selected to produce lean meat efficiently under improved feeding and management conditions. The genetic improvement of indigenous breeds, adapted exotic breeds and their crosses have been carried out by All India Co-ordinated Research Project on Pigs and breeding farm attached to Veterinary Institutions.

13.16 Breeding Objectives

Skill and care in the selection of breeding stock are essentials to success in pig breeding. There are certain qualities and characteristics to which close attention should be directed. The annual production of a sow used solely for pig meat production is assessed by the number and grades of carcasses processed from her offspring and the stock used for breeding. The assessment is done by their productivity, i.e. litter size, number of piglets weaned etc. In recent times, the present market demands a lean carcass with minimum of fat. The important objective of the swine breeder must be maximum efficiency of production.

The factors which are of great importance should be chosen for breeding.

(i) Number of Rigs Reared

- a. ***Number of pigs born per litter***: About twenty or so eggs released by a sow during ovulation may be fertilized. Several of the resulting fetuses or embryos die and wither away before farrowing operation. The genetic control of litter size is very limited, because of low heritability.
- b. ***Number of litters born per year***: If early weaning of pig at three or five weeks is done, more than two litters can be achieved. Breeding record are essential to determine the ability of the sow.

(ii) Economy of production

- a. ***Growth rate***: The daily weight gain of a pig is a measurement of its rate of growth. Genes determine the maximum rate of growth.
- b. ***Food conversion ratio***: It is closely associated with growth rate. It is the ability of the pig to convert food into meat and fat. Marked genetic variation exists between and within breeds and improvement can be realized by selection of breeding stock.

(iii) Carcass quality

The quality of the carcass is the end result of a growing process which not only involves the pig's overall growth rate but the comparative rates at which its bone, muscle and fat tissue develops.

Genetic selection within breed has basically produced strains of pigs suitable for market requirements- All markets require minimum fat and maximum lean tissue development.

13.17 Breeding Systems in India

The selection of breeding systems might offer a means of obtaining superior performance of pigs.

The best approach to intensive selection within a pure breed population will provide outstanding sires for use in commercial crossbreeding programs.

The following breeding systems have been adopted in India for improvement of pigs:

13.17.1 Cross-Breeding

The cross-breeding is the mating of individuals of two breeds. In commercial pig production, most of the pig slaughtered are crossbreds. The sole purpose of crossbreeding is to take advantage of the observed improvement of 5 to 15 % in growth rate, efficiency of feed conversion and reproductive traits is common in cross-bred animals. The major objective of purebred swine production is to identify and propagate superior sires for use in commercial production primarily in cross-breeding programs as well as to propagate and identify superior females for maintaining valuable genetic material.

13.17.2 Outbreeding and Inbreeding

Improvement in commercial swine production will be only as rapid improvement in the parent's purebreds. Outbreeding and inbreeding both involve mating of individuals within a breed. Outbreeding is the mating of the individuals less closely related than the average of the breed. Inbreeding is the mating of individuals more closely related than the average of the breed.

The selection of breeding system might offer a means of obtaining superior performance in swine. The best approach to intensive selection within a pure breed population will provide outstanding sires for use in commercial crossbreeding programs.

13.18 Selection of Breeding Pigs

13.18.1 Physical basis of selection

The changing food habits of man, the economic competition from other types of edible fats, the increasing availability of other meats such as beef and poultry and most recently the repeated assertions of a relation between animal fats and certain vascular disorders have increased the importance of the physical basis of selection.

(i) Essential carcass characteristics

The consumer demands a maximum amount of muscular tissue with a minimum of fat. It is logical to stress the selection of swine in relation to the carcass characteristics at slaughter.

The carcasses of bacon are graded on weight, length and the thickness of fat. The carcass length of acceptable meat type pigs slaughtered when weighing from 200-220 lbs should be from 29-31 inches. Length is not so important in pork and heavy cutter carcasses. Thickness of back fat has been recognized as an important measure of carcass quality. In the carcass quality, back fat is usually measured at several points such as first rib, last rib, and last lumbar vertebrae. All buyers are seeking a carcass which is as lean as possible irrespective of the weight of the carcass required. The back fat is measured by back fat probe method, use of leanmeter and ultrasonic technique etc. These mechanical methods for determination of back fat thickness of the live animal are valuable to supplement visual appraisal and the use of scales in the selection of meat type breeding stock and the production of higher quality pork carcasses.

(ii) Essential performance characteristics

Factors such as litter size, mothering ability, lactation, growth rate and the efficiency of feed utilization are the most important in swine production. Large litter size is essential for efficient pig production. Selection for litter size has been practical for generations, to improve it by genetic means. The weaning of a large litter size indicates a high ovulation rate, absence of unusual embryonic mortality, a satisfactory mammary system and presence of good mothering ability. The animals of equal merit should always be selected from the larger litters. The number of pigs weaned and their weaning weight is certainly important in profitable pig production and is influenced by genetic makeup. Weaning weight may be influenced by vigor of the pigs, milk production and the environmental factors like feeding and management practices. The breeder must aim for low mortality and good health in suckling pigs. Post weaning growth rate and type of growth (muscle or fat) are much more highly heritable than litter size or weaning weight. The rate of gain and economy of gain are closely related. The time from birth to slaughter weight has been progressively reduced. The good type fatterer pig

reaches slaughter weight of 90 kg at six months of age. Feed conversion efficiency is affected by the nature of the ration, the sex, environmental temperature, management practices and genetic make up of the pig.

(iii) Anatomical features in swine selection

The physical factors which are associated with the general appearance of the animal are responsible for carcass quality and appearance. All breeding animals should be of sufficient length of 29 to 31 inches in the progeny at slaughter weight of 90 to 100 kg. The heritability of nipple number is relatively high and is an important point in selection. The colour of pig has been an important characteristic in the development of the breeds, but is not considered as a limiting factor in efficient pig production.

(iv) Vigor and longevity

The ability of the newborn pig to survive, especially if the environment is unfavorable, is extremely important in profitable pig production. In the survival and longevity of swine, the role of genetic make up can not be overlooked. It also depends upon the freedom from disease, environment and managerial conditions.

13.18.2 Breeding Swine Scorecard

	Perfect Score
GENERAL APPEARANCE	25
Type-heavy muscled, lean, trim, firm smooth long bodied ham and rump should be wider than rest of body, moderately deep uniformly arched top well balanced and stylish with a high degree of development in the valuable region of the hindquarters. same standard as for the market barrow.....	(12)
Size - ample size, scale and raggedness for age.....	(13)
CONFIRMATION	45
Hindquarters.....	(26 points)
Hind legs - set wide apart, out on the corners giving an Indication of abundant muscling.....	(2)
Ham - Wide deep long, full, firm, meaty, deep in the seam..	(9)

Rump - long, wide, uniformly turned high tail setting meaty..(6)
 Loin - muscular-turn, long, lean.....(8)

Forequarters.....(14)

Back - muscular turn, long, lean, uniformly, arched full spring
 of rib.....(7)

Shoulders - smooth, muscular, free from fatty-creases and
 wrinkles, no evidence of fat deposits at the elbow.....(4.5)

Head - clean-cut, trim, firm, jowl.....(2)

Neck - short.....(0.5)

Middle.....(5 points)

Deep, roomy middle but not loose or wasty, belly trim and firm
 deep ribbed.

BREEDING QUALITIES (30)

Underplanning(13 points)

Legs - straight as viewed from side, front, and rear squarely: set
 under corners of body, strong, straight toes.....(8)

Pasterns - strong, short, straight but not buckled over.....(1)

Action - free easy, unhindered walk, not stiff or 'peggy'(4)

Mammary system(12)

Six (6) sound nipples on a side, nipples prominent and evenly
 spaced, no evidence of inverted or blind teats.

Breed Character(5 points)

Head - varies with the breed, wide between the eyes, sows
 feminine and boars masculine.....(3)

Ears- relatively small and refined, not large and coarse thereby
 hindering vision, breeds having erect/ears should show no
 tendency for dropping. Breeds having drooping ears should
 show no tendency for being erect.....(2)

Total.....(100)

13.18.3 Genetic basis of Selection

The Performance of a pig is determined both by its genetic composition and environmental factors. Growth rate, type of growth (muscle or fat), milk production and reproductive performance are affected many pairs of genes. The known genetic principles are applied to production and to provide environmental condition which will allow the genes to express

themselves in the most, desirable manner for economic pig production.

i) General Principles of selection

The pigs are selected for many traits simultaneously. Improvement, can be made only if the animal vary in the genes they posses. The selection of the pig on the basis of genetic make-up, heritability etc. plays and important role in genetic improvement.

ii) The concept of heritability

The heritability Is expressed as a percentage (0 to 100 percent), or unit fraction and is an estimate of the average regression of phenotype on genotype.

Heritability describes the portion of the deviation from overall average which; is due to genetic causes. It tells us how effective selection will be.

It is essential in making breeding plans. If the heritability of a particular characteristic is high, mass selection with a minimum of attention to pedigree, family performance or progeny testing may be successful.

The heritability estimates for some economic traits in pigs are shown in Table 13.18.3.1.

TABLE 13.18.3.1 Heritability estimates for economic traits

Economic Trait	Heritability (%)
Pigs born alive	10
21 days litter weight	15
Feed Efficiency	30
Days to 250 lb	35
Backfat depth	40
Lean percentage	40

Most carcass characteristics are highly heritable, selection of superior female and male can effect immediate significant improvement of carcass quality in their offspring.

iii) Lethal effects of genes

In some cases death results from the presence of certain genes in the newborn pigs. These genes have become known as lethal genes. These are probably recessive in nature, atresia ani or closed colon, hydrocephalus, posterior paralysis, muscle contraction, certain deformities of the limb etc. These abnormalities have been identified with the genetic composition of the animal.

iv) Deleterious effects of genes

Hernias of the scrotum and abdomen are common in pigs. Scrotal hernias are particularly undesirable. Since this trait is known to be heritable, boars having scrotal hernia are never used for breeding. Inverted nipples which prevent the pigs from suckling are also transmissible. The selection of breeding stock for large litters must be accompanied by selection for at least 10 to 12 sound mammary glands.

13.19 Hybrid pigs and Vigor

When two breeds of pigs are crossed, their offspring sometime show qualities superior to either of the parent stock. This is known hybrid vigor (heterosis) and is more often seen in characteristics which have a relatively low heritability. Pig breeders have known of the general phenomenon of hybrid vigor for a long time and many crosses between breeds are recognized as sound commercial successes. A hybrid pig should be the progeny of stock which have been specially selected for

- (a) improved performance within the breed and
- (b) ability to be crossed with other selected breeds and show a consistently high level of hybrid vigor.

The aim of the production of the hybrid pig is the production of an economically growing pig with a high lean content in the carcass, i.e. a reduction in the cost per kg of lean meat. The production of hybrid pigs has a highly specialized business and must be accompanied by a vigorous performance testing program

and the maintenance of a number of inbred lines. Boars of types not representative of recognized breeds are being produced and sold for commercial use by a number of medium to large companies.

13.20 Performance Testing and the Improvement

Performance testing has been adopted to estimate the breeding value of pedigree boars. The relative breeding value of a particular boar could be assessed by comparing the performance figures of his offsprings with contemporary average figures.

Performance testing is designed to assess the potential of a young boar for siring profitable progeny. A group of profitable progeny of four pigs from the same litter, each comprising two boars, one castrate and a one gilt, are sent to the testing station. The pigs are weighed on arrival and their individual weight should be between 18 to 25 kg. The test commences when each boar weighs 27 kg and the sibs (the castrate and gilt) weigh 54 in total. The test is completed when each boar weighs 91 kg and the sibs collective weight is 165 kg. The sibs and boars are housed separately in order to record their feed consumption. Then the records are assessed to evaluate the economy of production and carcass quality. The purpose of testing the castrate and gilts are to obtain detailed carcass information, i.e. sample joints are dissected into lean, fat and bone. Additionally feed conversion efficiency, live weight gain and ultrasonically measured fat depth are recorded for each boar. The information is expressed in a selection index as a points score for each boars. Since the boars tested are selected as above it will bring out improvements in most commercial herds.

13.21 Breeding for Commercial Growers

The pig breeding company provides two services; trouble free provision of male and female herd replacements and improved pig stock. They offer a stock of improved growth rate, carcass quality and reproductive characteristics. These companies test and select in their purebred nucleus herds in a similar way to pedigree breeders and in addition will cash in on

hybrid vigor by presenting a crossbred female as a branded product.

The object of the commercial grower is not to become involved in the breeding of improved pigs, but merely to procure them. These improved pigs are supplied by the breeding companies in the shape of cross bred females and selected males or by provision of grandparent stock for a farm multiplication of females. These companies produce hybrid pigs for fattening purpose. In recent years, the rearing of feeder pigs have been increased by the small farmers as it is easier for them to buy pigs than maintaining a breeding herd.

Genetic improvement of pigs has played a major role in increasing out-put from Indian pig Industry, especially in the last ten years. The genetic improvement of pigs is aimed to increase the sow productivity, economy of gain and carcass quality. In order to encourage the right system of breeding of pigs, for commercial characters, selection holds a key position. The attempts are made to improve the pig production in order to fulfill the present market requirements.

13.22 Breeding Plans for Improvement of Pigs

Any improvement in livestock can be brought about by two basic ways. The first is the plan in which breeder selects the breeding stock and second is the choice of the mating system for rapid improvement. The mating system from which a breeder may choose are random mating (pure breeding), inbreeding and outbreeding, while selection may be based on the individual's own performance, pedigree estimates, progeny testing, sib testing or a combination of these informations. The breeding plan are the one which has to be used in conjunction with selection method for desired improvement under the present social frame work, structure of animal industry, keeping in mind the needs of the public.

13.22.1 Role of Breeding Methods

Random mating and inbreeding as a matter of fact do not bring any change in gene frequency which is genetically responsible for bringing improvement. However inbreeding tries

to reorganize different combination of desirable genes and increases the homozygosity in the population thus making the individuals more pre-potent having higher accuracy of selection. It also exposes many lethals and semi-lethals which can be eliminated through selection. While outbreeding brings about a sudden change in gene frequency resulting in sudden jump in improvement and also helps in transferring desirable gene in the population. It also provide an advantage of hybrid vigor resulting from heterosis which is exhibited by better adaptability or fitness value, survivability, faster growth, better reproduction and production performances. On the other hand inbreeding brings about a fall in fitness value and adaptability, resulting in poor performance.

13.22.2 Role of selection

The primary aim of selection is to predict as accurately as possible the breeding value (genetic worth) of animals available for breeding and use them on the basis of their prediction. What one really need is the reliable measures, of the extent, to which the breeding value of an animal is correlated with its own performance or its ancestor/progeny/sibs. One must also know how these correlation are affected by environmental variation, Mendelian sampling errors, dominance and epistatic relations among genes and differences in the number of offspring or sibs that are available for testing. Since the breeding value of an animal can not be observed directly, one has to depend on the Wright's path coefficient methods for its estimation.

13.22.3 Factors responsible for improvement

The rate of improvement expected from selection depends upon:-

- i) the selection differential i.e. the difference in performance between the selected individuals and the base population. This depends on the amount of intensity of selection applied;
- ii) the degree of heritability (h^2), or accuracy by which the animal's breeding value is estimated and
- iii) the average interval between generation or average age of parents when their offsprings are born.

The first two factors are positively related with the improvement while the third one is negatively. Thus higher the heritability, more will be the improvement. Therefore one also needs to find out how does the heritability might be increased. Lush (1945) has emphasized three factors for increasing heritability, which are as under:-

- i) by minimizing or preventing environmental variation or correcting for these effects if they do occur.
- ii) by increasing number of records per individual so as to minimize error from random non-correlated environmental variation and
- iii) by selection based partly on the merit of ancestors, collateral relatives and progeny test.

Thus lower will be the heritability of a character, the more is generally gained by using information on relatives in addition to individuals.

Un-controlled Factors

Other factors that govern the rate of improvement through selection, are largely beyond the breeder's control, e.g. relative economic value of different traits, rate of reproduction, age when its phenotype can be measured and traits requiring sacrifice or sex limited traits. Since some of these factors may differ rather widely for different traits within the same population or for the same trait in different population, one breeding or selection plan would not be expected to be equally effective under all circumstances.

Factor of Personal Judgment

In addition to the factors just cited and variously influenced by them are factors of personal judgment that must usually be considered in order to maximize the rate of improvement from selection. Some of the more important factors are:

1. Choice of measures of individual merit;
2. Amount of culling that may reasonably be done during the early stages in the animal's life;
3. Optimum group size in progeny test and sib test selection;

4. Choice of environment including feeding and management, and optimum method of selection where the economic value of animal is measured in terms of several important characteristics.

13.23 Improving Swine

The primary objective of swine production is to get maximum lean meat in the form of bacon and ham. The productivity of ham and bacon per sow unit depends upon many factors like type of breed, litter size, litter weight at birth/weaning, age at slaughter weight, feed efficient growth and carcass trait. If these traits are improved, the total improvement per litter will take place. Therefore it is essential to know the different germplasm available in the country and all over World in relation to these traits. Similarly as there are many different traits responsible for improvement, it is possible that many may be genetical correlated with few traits. Therefore it is also essential to know the genetic correlation among these traits so that one can identify few important characters which may be highly correlated with rest, for incorporation in selection index. As the response depends upon the accuracy, which is measured through heritability of the trait, it is essential to know the inheritance pattern of these traits. This will also help to decide which selection tool a breeder should use.

All breeds currently predominant in USA are known as “meat type”. This is also true for so called “hybrid” swine which do not represent specific pure-bred. Historically swine breeds in USA were classified (1) Lard type and (2) Bacon type. The so called Lard type was developed during mid and late 19th Century to meet the demand of lard. The present day Duroc, Chester White, Poland-China, Spotted swine and Herefords are all lard type. While in Europe, the Tamworth, Yorkshire and Berkshire breeds were developed. The Tamworth and Yorkshires are of bacon type in England while the Berkshire is considered an intermediate or “Pork type”.

The h^2 of litter size at birth, at weaning of weaning weight of the litter are low heritable (<0.2). While all estimates of h^2

of individual pig weights at weaning age i.e. 35-56 days of age are also low, indicating that weight at that age is largely dependent on nursing ability of sow rather than pig's own genes.

Leanness measured as back fat thickness and carcass traits at highly heritable. However the yield of carcass characters and leanness are negatively correlated. Thus it would be expected that h^2 of yield would also be at least moderately high. Therefore it can be concluded that the litter size and litter weight could not be improved so fast, the selection would not be so accurate. As litter size and weight are being influenced by mothering ability of dam, efforts should be made to get good mothers for breeding through some breeding systems. The only trait which can be influenced greatly by selection is the carcass trait and weight at slaughter age. Genetic correlation between rate gain and efficiency of gain are positive and medium. Thus there seems to be only three parameters which have a future for improvement in swine. These are :

- (1) rate of gain
- (2) efficiency of gain
- (3) carcass leanness.

Recent estimates of genetic correlation among all three traits are positive

Effectiveness of Selection

Before taking any decision on breeding plan one should know the results of experiments on effectiveness of selection. It is reported that gain expected for any one character of importance i.e. number of progeny weaned/litter or litter weaned weight, or average weight at slaughtered age (154 days) or back fat thickness are relatively small. The progress in any one generation can not be expected to be great, even if selection pressure is put only on one trait. The most of the experiment, an intensive selection resulted in some degree of inbreeding in the herd due to higher prolificacy of species. This resulted in inbreeding depression thus canceling whatever improvement made through selection, which discourages selection. A similar discouraging item for selection comes from realization that

continuous automatic selection for large litter size resulted in optimum which a sow can handle with fullest fitness. Any increase in this will result in poor fitness resulting in more mortality. Thus one can see that selection could only be effective in swine for carcass traits and the growth. However, litter size could not be improved by selection. It will require creating a new genotype dams having better mothering ability which could only be achieved through cross breeding.

13.24 Swine breeding system in Foreign Countries

Keeping in mind the above facts based on experimentation the commercial swine production in USA is predominantly based on cross breeding.

13.24.1 Seed Stock Breeding

Seed stock herds are of male line raised for the purpose of producing boars to be used for crossbreeding in commercial herds. Intermediate seed stock producers could maintain herds of a pureline or breed and mate only enough superior females to produce replacement purebred stock. While the rest to be mated to boars of another breed or line of swine. The female crossbred offspring are being sold to commercial producers -generally at weaning age. The commercial producer uses these crossbred female for mating to boars of third breed or line so as to produce three-breed cross commercial progeny to be raised for slaughter.

13.24.2 Cross-breeding

The crossbred sows going for commercial herd are from two breeds or line selected for maternal character like high litter size at-birth and weaning and litter weight. The boar line raised for commercial breeding can be selected for maximum growth and desired carcass character using selection index. As these characters are medium to highly heritable, the selection will be more effective. Specific three breed crossing systems are used to a considerable extent in Great Britain and to some degree by other European countries.

13.24.3 Hybrid Swine Breeding

Some of the large producers in USA of so called "Hybrid" Swine are developing types for use in specific crosses with

specialized paternal and maternal lines or crosses. If successful, these systems will ultimately include sales of both male line and female line for commercial producer, as it is done today in poultry. In USA most producers follow some type of crisscrossing or rotational cross breeding scheme, so as to maintain hybrid vigor in females. In some cases, the plans followed are quite specific and systematic involving either a two breed criss-crossing or a three or four-breed rotation. The reason for using this system over specific three-breed cross are:-

1. To avoid introduction of diseases through purchased commercial crossbred sows.
2. Due to additional cost of purchasing crossbred female.

Criss cross or rotational cross breeding programme requires that all the breeds used be at least reasonably good for all round merit.

13.25 Swine breeding in India

India do not posses any recognized breed of swine. The indigenous or *desi* pigs are all non-descript types. However, few types are specific to the regions. The majority of Indian population (70%) are vegetarians and further among remaining non-vegetarian population there are few ethnic groups who have a restriction on consumption of pork. Therefore Indian pigs were never developed or selected for pork. With the recent industrial development and education in the country, the animal protein requirement is growing at fast rate. This has generated the demand and interest for good quality pork/ham/bacon in the country.

Although the production potential of indigenous genotype breed is low, they are well adapted to the different production systems in India. Under small scale extensive production systems where most of the indigenous pigs are reared, some of the exotic breeds do not even survive. Therefore, simple upgrading methods that have been utilized in India to replace indigenous population with superior genotypes cannot be applied to improve all the indigenous pig breeds. Moreover, such changes in population structure might constitute a threat to the pig

population of developing countries, causing a significant reduction in valuable genes. Even when exotic breeds are adapted to semi-intensive and intensive production systems, further improvement in such breeds might not be expected to come from regular importations because of possible genotype-environment interactions.

Hence, genetic improvement of indigenous breeds and adapted exotic breeds has to be carried out under existing management and feeding systems in order to produce suitable high producing genotypes for the different production system.

It is a well known fact that the pig if raised for pork as commercial enterprise will compete with human feed being a monogastric animal. While the country is not in a position to divert any grain towards animal feed. Due to low feed conversion ratio, the requirement of grain is about 2-3 times more. There is a need to identify the area and develop efficient marketing system before introducing any swine breeding programme in the country. Once it is done, then the breeder has to develop a dam line of pigs which has better mothering ability with average optimum growth enough being sustained by the nutrients available in the area with some additional concentrates. As the indigenous pigs has the capacity to utilize agriculture by-products and wastes, but do not have good litter size, mothering ability and faster growth, a breeder has to develop a dam line suitable for commercial pig production. Similarly the sire line having faster growth and better carcass traits has to be identified and bred as seed stock.

Development of Dam line

Although may exotic breed can do well under our climatic condition, it will not be desirable to introduce them at present in rural area because the rural farmer could not sustain their feeding and management. Looking to the above limitation the dam line has to be a crossbred with 50% indigenous blood. The crossing of local pigs to develop a commercial dam line, needs identification of an exotic breed having better litter size, litter weight at weaning and mothering ability. The breeds which

have these qualities are Large White Yorkshire and Landrace. However Yorkshire should be preferred over Landrace has excellent growth which will demand extra energy in feed in which the country is deficient. The other points needs consideration is that country has a good experience with Yorkshire over generations hence be preferred.

The local crossed with Yorkshire will produce commercial female to be the future dams, be marketed to nearby town where the commercial stock breeder are located. Care must be taken only to generate required number of crossbreds which can be marketed at weaning age otherwise the farmer has to bear a loss. The crossbred males marketed has to be raised by commercial breeder up to slaughter age only and be disposed as there will be different sire line for commercial dams.

Development of Sire line

The male line should be pure exotic having faster gain and better carcass traits. Therefore these must be located in towns as seed stock. These seed stock will be bred for future breeding boars based on selection for faster gain and better carcass trait using selection index. The breeds of choice will be American Landrace or Spotted Swine or Duroc. The males will be marketed to commercial producer, who will met them to the crossbred dam to produce 3-breed cross commercial piglets. The females of the seed stock for sire line will be selected on the basis of number farrowed and number weaned to be used for future mating in each generation, while the rest females will be sold for slaughter.

Thus the rural area should only breed indigenous female to exotic Yorkshire sufficient enough to meet the commercial dam requirement of the urban area. The rest must be bred to indigenous only. While the urban area where the market for slaughter is available have seed stock breed for male line and the commercial breeder for three-breed cross commercial pig production. The detailed plan is given in Fig.13.25.1. This plan will fit well under our condition as it does not require progeny testing or planned breeding or selective breeding in rural area.

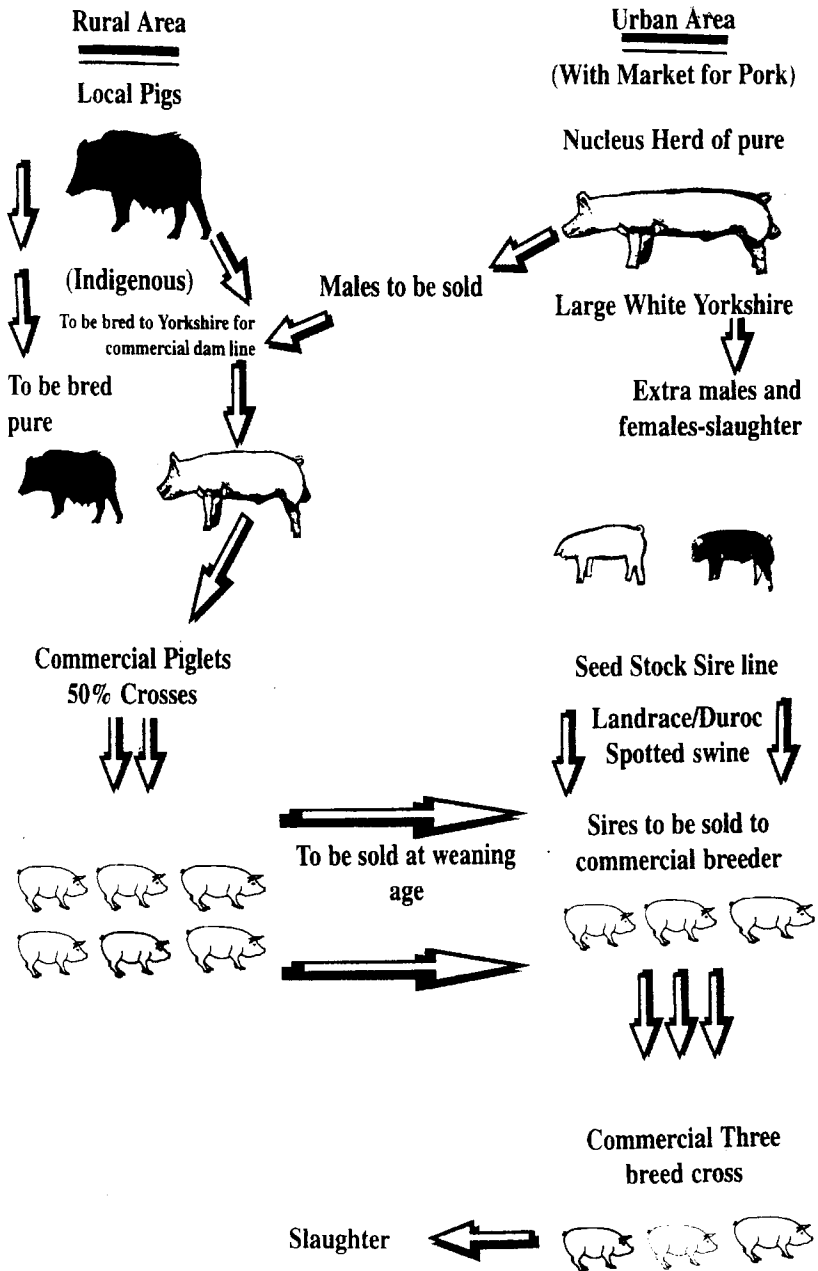


Fig. 13.25.1 Breeding Plan for India

There is no need for even identification as all the cross-bred pigs generated by Yorkshire crossing will identify itself with white color which can be sold to commercial producer.

The urban area also, where all technical knowhow can be made easily available, will be raising limited number of exotic pigs as seed stock for generating the male line. The rest of the farmer will be going for commercial production which do not require any breeding plan.

14. BIODIVERSITY OF PIGS

14.1 What is Biodiversity?

Animal genetic resources include all species, breeds and strains that are of economic, scientific and cultural interest to humankind for agriculture both present and in the future. Animal domestication began some 12000 years ago when people began selecting animals for food, fibre, work power and manure.

Of the 30 million of living organisms on earth, less than 15000 are birds and mammals, and of these about 30 species are domesticated for the production of meat, milk, wool and other products. These 30 species have been domesticated by humans over the past 12000 years. In this process separate and genetically unique types of breeds have been developed to suit the local climate and community's requirements. Approximately 4000 breeds have been developed from these 30 species, which are used for food and other products.

The spectrum of genetic differences within each breed of pigs, and across all breeds within each pig species, provides the variation or diversity for the species, which has developed during millions of years of evolution. Each breed of pig has been formed and stabilized over the more recent millennia. The domestication has also formed and stabilized each breed of pig and pigs were developed to provide for human needs within these new environments.

The genetic diversity among animals is to be preserved for future generations as much as do other manifestations of our cultural heritage, such as architecture or art.

14.2 Pig Genetic Diversity

It allows farmers to select stocks or develop new breeds in response to changes in the environment, threats of disease, new knowledge of human nutrition requirement, changing market conditions and societal needs, all of which are largely unpredictable. Indigenous pigs and wild pigs often possess valuable traits such as disease resistance, high fertility, good maternal qualities, unique product qualities, longevity and adaptation to harsh conditions and poor quality feed, all desirable

qualities for low-input and sustainable pig husbandry. The Thaihu pigs of China, for instance, offer valuable traits for swine breeders worldwide. This group of pigs have thick, wrinkled skin and long, droopy ears. They can use a high proportion of forage foods in their diet. The adult pig has little lean meat. But Thaihu pigs reach sexual maturity in just 64 days, are extraordinary fertile producing an average litter of 16 piglets compared to only 10 for Western breeds, and produce juicy, tasty meat.

14.3 Reasons for loss of Diversity

The earth comprises a vast range of environments in which the production of meat must be practiced to provide for our needs. These environments change over the season, the years and the decades. With increase population pressures, the quantity of food and other products must increase. Indeed, a doubling of meat production is required over the next 10 years. The quality of meat and other meat products sought by communities is also affected by variation in their purchasing power.

Pigs are more complex and costly organisms. Each pig carries about 12000 genes in its blueprint and these interact with each other and with the environment during the production life cycle. Further changes will continue to occur in many different environments and in humankind's requirements. These changes take place over period of time, years and decades. The technology to achieve artificially the vast array of changes in genetic make-up which could be supplied by currently existing and readily available genetic resources does not exist now. The management costs required to maintain the existing pool of diversity, particularly in such a way that it covers a range of possible future uses, are negligible compared with the massive costs would be involved by conservation by Embryo Transfer Technology and other methods of cryo-preservation.

The changes in the production of pork and pork products influence local ecosystems. The different requirements of pig and breeds and colour preference have different effects on the interactions with the respective production environments.

Sustainability in these different environments will require different genetic types of pigs.

The important reasons for loss of domestic breeds of pig are as follows:-

1. Indiscriminate cross-breeding when combined with rapid reproduction may lead to loss of domestic indigenous breeds of pig.
2. Non-availability of pig breeding policy for pig improvement is primarily responsible for disappearance of indigenous breeds of pig.
3. Many pig breeds can be lost when undue emphasis is given to a specific productive trait- for e.g.. litter size without proper consideration of the nourishing ability of the sow.
4. There is no market or government incentive to utilize 'old breeds'. These incentive would involve a method of compensation for the production loss incurred to ensure that some farmers continue to utilize and maintain the breed of pigs.

14.4 Obvious Importance

The industrial farming systems, tends to reduce diversity, due to the selection for traits that match the requirements of meat production. Choosing prolific breeders or early maturity or litter size- means discarding other characteristics such as climate adaptability, disease resistance or the ability to survive on local feed resources.

The indigenous breeds well-adapted to harsh environmental conditions are often replaced by exotic imported breeds. These breeds may be high in production in their home environments, but are not as successful elsewhere. Local breeds are slowly disappearing, or have already vanished due to their low production potential.

The pig diversity which has evolved over more than 12000 years is also an integral component of our heritage, to be fostered for future generations.

14.5 What is a breed?

A breed is either a homogenous, sub-specific group of

domestic livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarly defined groups within the same species, or, it is a homogenous group for which geographical separation from phenotypically similar groups has led to general acceptance of its separate identity (Turton, 1974).

14.6 World Pig Genetic Resources

The World Watch List for Domestic Animal Diversity (WWL-DAD) initiates the global collection and regular reporting of this breed information on each species by listing those breeds which are categorized as endangered and critical, and those which current information indicates have become extinct. The data on FAO's Databank for Farm Animal Genetic Resources will become more detailed over time and as the WWL-DAD is regularly updated from this databank the trends in breed status should become apparent for each domestic species including pig.

14.7 Productive Vs. Less productive

Less profitable pigs are being slaughtered in favor of more productive breeds i.e. Large White for pork. It is undoubtedly better converters of feed into pork and in purely commercial terms a good investment choice; but there are scientific, practical and sentimental reasons for conserving non-commercial breeds.

In good scientific sense to preserve animal disease resistance, temperature tolerance etc. Some native breeds, for example, thrive in heat and sun. Tamworth pigs are ginger colored and so sunburn less easily than the more commercial Large Whites.

Tamworth produce two litters of 8 piglets per year, to Large Whites' average of 2.2 litters of 12 piglets per year. But the Tamworth pigs are hardier and live outside, while Large Whites live indoors. Their meat is fatter and tastier, and it produces that delicacy of crisp, slightly burnt skin known as "crackling".

Once lost an extinct breed can not be brought back to life, many breeds have been lost during this century. The last remaining Lincolnshire Curly Coat pigs, were sent for slaughter

in 1972. Attempts have also been made in Britain to “breed back” and reproduce animals similar to those of 2000-3000 years past. Wild boar have been crossed with Tamworth pigs to produce a red-and-black striped creature with a long, boar-like snout and strong resemblance to the archaeological remains of Iron Age pigs.

14.8 Exotic Vs. Native Pigs of India

In India, the exotic pigs are being maintained at Government Pig Breeding Farms. However, we have only few native breeds of pig i.e. Desi Pigs, Ghorri Pigs, Ankamali Pigs and Andaman pig. These pigs production potential is very low but they can perform well in adverse conditions.

14.9 Conservation of Breeds

Conservation of breeds is the sum of operations involved in the management of pool of genetic diversity to ensure that this can be maintained over time, which includes;-

1. The identification and listing of all breeds
2. Their description and characterization, in order to understand their unique qualities and potential contribution, and to find out the possibility of potential of breed to make the greatest variety of future contributions.
3. Monitoring the population statistics for each breed and regularly reporting to the world those breed population currently at risk of extinction.
4. Facilitating the current use of many breeds as possible, which is a most cost-effective way of conserving the gene pool for the future.
5. Storing adequate sample in the shape of frozen semen and embryos to enable the future regeneration of a lost population of pigs.
6. Implementing education and training programme in conservation genetics and in effective field techniques.
7. Assisting with the development of the necessary national and international policy and legal instruments.
8. Establishing a coordinated global system to manage the range of operations.

Criteria of Conservation

The conservation would depend upon factors such as the breed's current use, the climatic and social stability of the area in which it is located, the number of animals in the existing breed population and the extent and type of performance recording, cross-breeding, national breeding policy, culture and available finance.

Role of FAO

Food and Agriculture Organization of United Nations (FAO) had played the pioneer role in conserving animal genetic resources with a range of studies and publications commencing in 1948. Conservation activity increased following the FAO/ UNEP Technical Consultation in 1980, and in recent years FAO Committee on Agriculture (COAG) and the FAO Council have regularly considered animal genetic resource matters and supported the further development of a longer term programme.

14.10 Global Conservation Programme

FAO with the United Nations Environment Programme (UNEP) had established Regional Gene Banks in Africa, Asia and Latin America for the cryogenic storage of germplasm of endangered species and breeds. It also created a Global Animal Genetic Data Bank, in Hannover, Germany with the help of European Association of Animal production (EAAP).

Classifying breeds

Criteria for classifying animal breeds includes population size, recent growth trends, number of herds and the relative extent of pure and cross-breeding. Following European surveys in 1982 and 1985, the EAAP's Genetic Commission set the numbers for "endangered" status at below 200 sows for pigs. In cases where populations are declining or the number of breeding males is below 20, the criteria are 200 to 500 sows.

The Endangered Breed List

Once a breed is identified as endangered, efforts would be made to save it, through cryogenic methods and conservation of live animals *in situ* or *ex situ* in zoos.

14.11 World Watch List for Domestic Animal Diversity

The first World Watch List for Domestic Animal Diversity (WWL-DAD) was developed in November, 1993 by FAO with a view to create global early warning system aiming to help prevent the erosion of genetic diversity in those important species that are used to provide the wide range of food and agriculture for humankind now and in the future.

In first edition of WWL-DAD, ass, buffalo, cattle, goat, horse, pig and sheep was included.

The WWL-DAD(1995)

The 2nd edition of World Watch List for Domestic Animal Diversity (WWL-DAD) was published in September, 1995 by FAO. This provides information on Breeds at risk, extinct breeds and wild relatives of domestic livestock including pig.

The criteria for determining breeds at risk is as follows:-

Extinct

A breed is categorized as extinct if, it is no longer possible to easily recreate the breed population. This situation becomes absolute when there are both no breeding males (semen) and breeding females (oocytes), nor embryos remaining. In reality extinction may be realized well before the loss of the last animal, gamete or embryo.

Critical

A breed is categorized as critical if, the total number of breeding females is less than 100 or the total number of breeding males is less than or equal to 5.

In Asia and the Pacific Region, 3 breeds of China Pig i.e. Bamm Mini Pig, Ebei Black and Hexi are classified as critical. While in United Kingdom, Duroc and Middle White breeds of pig was classified as critical.

Endangered

A breed is endangered if, the total number of breeding females is between 100 and 1000 or the total number of breeding males is less than or equal to 20 and greater than 5.

In Asia and the Pacific Region, 5 breeds of Chinese pigs i.e. Bamei, Ding, Hetao Lop-Ear, Lingo and Yangxin are

classified as endangered. While in United kingdom, Berkshire, Gloucestershire Old Spot, Large Black, Welsh, Badger Faced Welsh Mountain and Cotswold are classified as Endangered.

Wild Pig Relatives

The *Sus scrofa* is the ancestor of most of the domestic breeds of pig. It is found throughout Eurasia and in North Africa, Sudan and Egypt. It is further divided into 25 subspecies. WWL-DAD:2 has also included wild pig relatives in their list.

14.12 Domestic Animal Diversity Information System

The Domestic Animal Diversity Information System- Stage 2 (DAD-IS 2.0) was launched on a CD-ROM in August, 1998 by FAO. It provides information and tools for management, teaching and research related to the characterization, sustainable use and conservation of farm animal genetic resources (AnGR).

15. SYSTEMS OF RAISING PIGS

15.1 System for efficient Pig production

The systems on the pig farm level, are defined by the way of assembling by means of technology, and physical factors and the management and labour factors within the environment for the production of primary livestock products.

The main physical factors involved in a system are land, climate, pigs, plants, buildings and equipment as well as feed, power, medicine and other inputs like money etc. A pig production system is primarily "location specific", but besides the factors describing the local physical and ecological environment the socio-economic conditions e.g. force on factors and products, tradition etc. also determine the system in order to satisfy market demand with the maximum profit or domestic or social satisfaction. Ecological and socio-economic factors are, on a whole scale, jointly important as major determinants for the intensity of the pig farming system and the systems for profitable pig production.

The income from pig production depends very much on the efficiency of the system used for pig production in practice. Due to the different ecological and socio-economic conditions from place to place even within a village- no particular system will be the most efficient in all places.

The small pig farm is characterized by much manpower, but less management and capital needs integrated systems with multipurpose crops and livestock. Particularly in developing country like India, the required technology will have to be simple, robust and cheap in use.

15.2 Need for Pig Production and income

The fast growing Indian population and insufficient human nutrition in many localities of the India demands increased food supply. The goal is better food supply to the consumer and higher income to the pig farmer or processor.

15.3 Efficient System for Pig Production

Efficient system may be systems which increase the domestic food supply, decrease the input of resources or increase

exports. An efficient system may be defined as the input of scarce resources, which will give the lowest average cost per unit of pork product.

15.4 Highly Productive Techniques

The development of highly productive techniques like machinery, equipments etc. is beneficial in developed countries. But in India where labour is cheap and capital less and expensive, the lower level of mechanization is most beneficial and profitable. There is a great need for improved low mechanized systems for the developing countries.

15.5 Systems of Raising Pigs

Pigs are raised under scavenging system, outdoor system and indoor system. The scientific system of raising pigs should be based on the practical approach of the local needs, using the cheaper and locally available housing materials.

15.5.1 Scavenging System

The traditional pig keepers belonging to socio-economically backward class of the society are compelled to follow old and primitive method of pig rearing. Under scavenging system, pigs are allowed to loose and fed on scavenging materials. This results in poor growth, high susceptibility to diseases, low litter size at birth and at weaning, low feed conversion efficiency and poor quality of pork and pork products. It does not require effort in management and practically no expenditure involves on feed.

15.5.2. Outdoor System

Outdoor system are an attempt of pigs rearing in a modified way of scavenging system. Pigs are generally kept in a strog enclosures either made of wood or strong fencing materials. This system requires a large area for free movement of pigs. Small wooden houses are also provided within the enclosures for shelter. Pigs are allowed for rotational grazing and small quantity of balanced ration after provided. No systemic breeding is practiced and sow for farrowing are shifted to a movable farrowing pen. Pigs reared under this system helps in increasing the fertility of the soil due to their habit of digging soil and



Fig. 15.5.1 Scavenging System of Raising Pigs

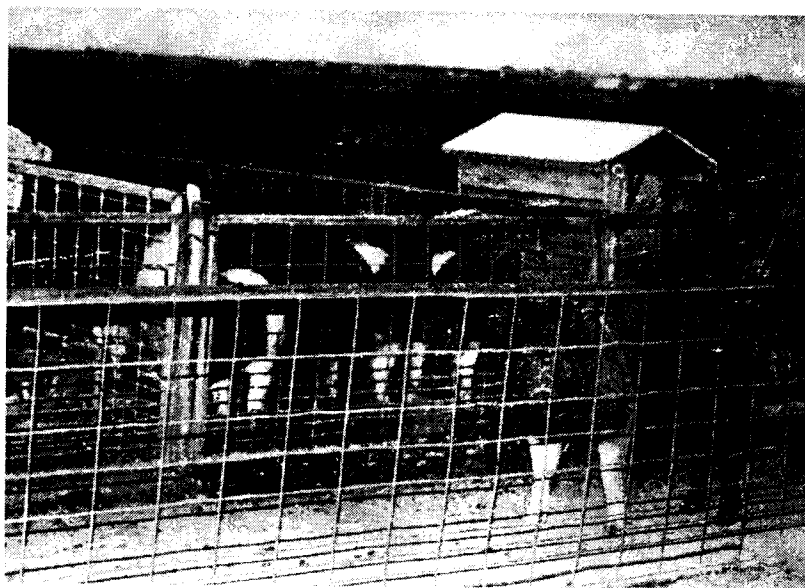


Fig..15.5.2. Outdoor System of Raising Pigs in USA

passing excreta. Pigs have full opportunity for the normal scavenging which can prevent mineral and vitamin deficiency. Special rations with mineral and vitamin mixture are not necessary for such pigs. Outdoor (free range) system is popular in Western Australia and could provide the means for achieving a better profitability.

15.5.3. Indoor System

This system of pig raising has gained popularity. The pigs are housed in a small area hence expenditure on labour, health cover, and other physical facilities are increased. The efficiency of feeding and management results in production of quality pork and good profits.

15.5.4 Pig-Fish-Algal Protein Production

Pig-fish-algal protein production is an integrated approach for maximizing profit. This not only reduces the problem of disposing manure but increases the income through fish farming, as pig faeces serve as food for fish, and for algal protein. The algal protein can be fed to pigs by replacing 8% to 15.5% soybean meal in the diet of grower and finisher feeds.

Pig Slurry as fish feed

Pig slurry are successfully fed to fish. The water is separated from the solid part of the slurry and used to fertilize the growing ponds so that large population of algae and other micro-organisms grow as food source for fish and pig.

Fish can convert large quantities of algae, but they are sensitive creatures. Feeding fish with slurry requires a perfect balance between providing maximum nutrients without poisoning the fish. Waste water from pig farm often contains damaging amounts of disinfectants, chemical dips and diet supplements such as antibiotics, copper and tin. Large quantities of these substances should be protected from being entered into ponds. Fish ponds are often conveniently situated between buildings, which also helps to keep pigs cool.

Bio-gas digestion of food for Algal protein

An effluent from an anaerobic lagoon holding pig waste water can support as high as 30g/m²/day. The high rate pond

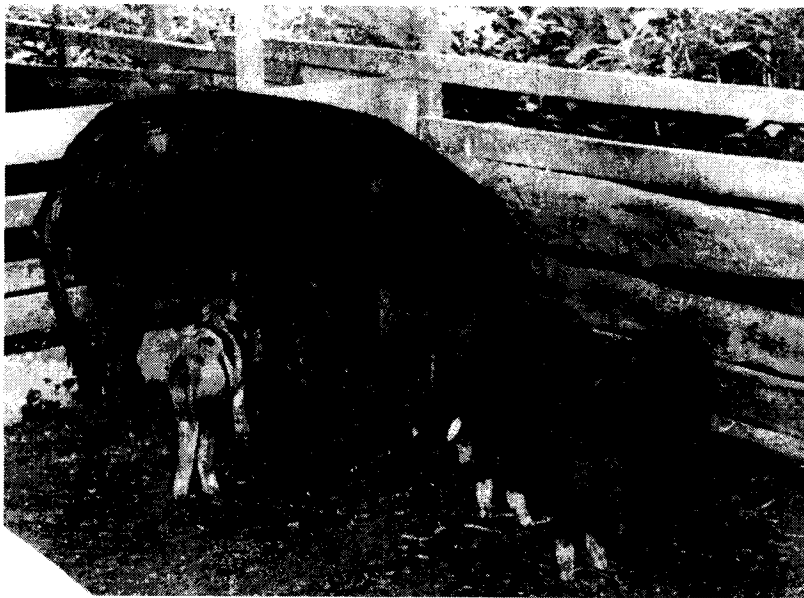


Fig. 15.5.3.1 Indoor System based on Rural Resources



Fig. 15.5.3.2 Indoor System based on Modern Technology

concept is a promising technology which can out-yield all other known crops for protein productivity. The algae can produce 56000 to 82000 kg protein/ha/year, as compared to Soybean (303-702 kg Protein/ha/year).

Pig waste water treatment is costly in colder countries, however, in India with warm tropical climate prevailing throughout the year, the high rate ponds for the production of protein-rich algae would be ideal.

High rate pond construction

A total of 290 m² of high rate pond is sufficient for the treatment of wastewater from 150 pig population and the optimization of algae production from these ponds.

The ponds can be constructed with clay bottoms with sand and rolled crushed-rock toppings to prevent scouring of the clay during mixing. Low cost wall construction can be achieved by using pre-cut corrugated asbestos cement sheets (corrugations running vertically) embedded in a shallow trench by concrete and sealed at the sheet overlaps by a bead of silicone sealant. The ponds should be equipped with low speed paddle wheel mixers operated intermittently on a timed automatic cycle. A depressed section in the single-loop pond raceways is used to control settleable solids build-up, with twice-weekly dislodging.

Process

Between 500-700 l of pig wastewater is collected each day and pumped to a holding and dilution tank. The diluted raw wastewater is then passed through fiberglass sedimentation tanks. The settled wastewater containing mainly soluble BOD flows into the ponds through a distribution box. The sludge from the sedimentation tanks is fed to a 5 m³ high rate digester to produce biogas, which will be used for firing a boiler to supply steam for drum-drying harvested algae. The system can produce good quality biogas containing approximately 65% methane.

The algae ponds are operated on a continuous basis with daily feed and withdrawal, with a depth maintained at 200 mm. Organic loading rates of 200 kg BOD/ha/day and detention time of 4-8 days are useful. The ponds are mixed intermittently (15

min every 4 hour) and the mid-channel velocity during mixing is 18-20 cm/sec.

Algae which can be grown

Micractinium, which is a green algae, grows in the ponds in clusters of spherical cells with radial spines which extend five or more times the diameter of individual cells.

Another larger algal species such as *Oocystis*, *Micractinium*, *Ankistrodesmus* and *Scendesmus* can be successfully grown.

Processing of algae for animal feeding

The harvested algae is steam-cooked at 100°C for 5 minutes contains an excellent quality of protein compared to soybean meal. The nutrients like amino acids are also present in sufficient quantity in steam cooked algal biomass. The can be used in formulation of pig diets containing algae.

In an experiment, daily harvest of algal slurry (7% solids) was steamed cooked and used as a protein supplement in a controlled feeding trial with pigs over 91 days, the control group received the standard feed with 15.5% soybean meal. For other groups, the 8 to 15.5% soybean meal was replaced by algae on dry weight basis. The feed conversion efficiency was increased from 3.45% (control group) to 3.56% (8% algae in diet) and 3.94 (15.5% algae in diet).

Algal Protein in feed of Pig

Algal biomass harvested by centrifuge and cooked by steam-sparging have a high content of crude protein i.e. 59%, which can replace 50% of the soybean meal in growing and finishing pigs diets without adverse growth reaction.

16. HOUSING OF PIGS

The gradual changes in the methods of raising have made the people to realize the need for good housing system for increasing the profit. The commercial pig production with exotic breed is being promoted in our country. It has increased the need for adequate and cheap housing. The pigs are highly susceptible to climatic stress. The heat regulating ability of new born piglets is very poor, and as a result, mortality increases in pre-weaned piglets due to extreme change in weather. Good housing can help in providing best management for production of high quality pigs.

16.1 Why good housing?

The main purpose of the house is to provide shade and reduce the radiant heat from the sun. The most effective way of reducing the intensity of solar radiation by painting the roof with white paint. Plant materials such as hay, thatch, straw and other grabs are excellent material for roofing on hot climates. An adequate roofing is necessary to protect the pigs from rain, sun and cold. A barrier running along the side walls is useful to prevent rats entering the building. Corrugated iron sheets and asbestos sheets are good, permanent roofing materials. Corrugated iron sheets should have a inner roof of light timber. This is necessary to prevent secondary heating of pigs produced by the heating material. This can be done with locally available materials such as leaves, straw and bamboos etc. But these materials should be covered with wirenet to protect it from birds and rodents.

Regardless of the type of house, construction should provide strength, resistance from warm and dry conditions. The pigs have powerful biting jaws and strong snout. Building and fencing must therefore be constructed in such a way that the pigs cannot either pull them down or root them out. Materials like stone, bricks, concretes are suitable for construction of pig houses. The walls of the building should preferable be cement plastered to form smooth cleanable surfaces. Concrete floors are the best and most durable, easy to clean, non-absorbent and

non-porous and non-slippery if rough finished. Cement floor should be finished in such a way that it provides a reasonable grip. Floors can be solid, semi-slatted or fully slatted. Normally one layer of concrete about 100 mm thick, on a consolidated gravel base, is sufficient to give a good floor. Concrete proportioned 3:2:1 or 4:2.25:1 (Gravel:Sand:Cement) is commonly used. The floor is divided into sections of 3x5 or 4x4 meters, as per the building plans. The slatted floors are widely used in intensive pig houses. The slatted floor makes the cleaning easier since a lot of manure is pushed through the slots. It also reduces the chances of spread of disease and helps to maintain comparatively a cooler environment so that more number of pigs can be housed. Slats can be made of timber, concrete or plastic. Timber slats should be made from quality, non-splintering hardwood.

16.2 Location or Site

A good location for a pig farm should meet the basic requirements like road communication and transportation, reliable water supply, well managed underground drainage system and sufficient distance from residential areas so as to avoid nuisance from odour and flies. The site of the building should be planned to give protection from the sun and exposure to wind. An east-west orientation is usually preferable to minimize exposure to sun. A fairly light, more or less self draining soil is always preferable and usually the higher part of a site should be selected for construction. Main supplies of electricity should be available. The site should be chosen with great care as it plays an important role in determining the success of the new project.

16.3 Types of Construction

A building for open confinement is essentially a roof carried on poles or pillars. In some cases it is preferable to give gable walls on one side protection from winds. These walls can be built temporarily from straw bales and is removed during hot weather to allow maximum aeration. Permanent walls must be provided with large openings to ensure sufficient air circulation

in hot weather. An open building for fattening pigs includes a central feeding alley and manure alleys along the outside walls. The 1.20 meter wall around the building serves to reduce heat reflected from the surrounding ground. Ceiling fans may be provided for air movement among the pigs.

16.4 Space Requirements and Pen Layout

The requirement of floor area per pig varies depending upon the size and age of the animal and prevailing climate of the area. Pigs on solid floor requires a greater area. The requirements of space are given in terms of length and widths of pens. There must be sufficient space for feeding trough to ensure that all the pigs in the pen get adequate quantity of feed. The guidelines for the space to be allowed for each condition is given in Table no. 16.4.1.

Table: 16.4.1 Space requirements for pigs

Pig weight (kg)	Area per pig (square meter)		Area per Pig (square feet)	
	Solid	Slatted	Solid	Slatted
4-11	0.37	0.25	4.00	2.7
11-18	0.56	0.28	6.00	3.0
18-45	0.74	0.37	8.00	4.00
45-68	0.93	0.55	10.0	6.0
68-95	1.11	0.74	12.0	8.0

Farrowing Pen 1.52X2.13m(5ftX7ft)

Sow stall 0.56m wide X 1.67 m to 2.13 m long. (1 ft 10 inch X 5 ft 6 inch to 7 feet) depending on the size of the sow.

The requirement of spaces are given in terms of length and breadth of pens and varies greatly depending on the building plan.

The sufficient space for feeding trough should be allowed to ensure adequate quantity of feed to all pigs.

The space requirement of feeding trough of pigs are given in Table 16.4.2.

Table 16.4.2 Space requirement for feeding trough.

Pigs weight (kg)	Trough space per pig	
	(mm)	(inch)
11-18	150	6
18-45	250	10
45-68	290	12
68-95	330	13
Sows	350	14

The above figures indicate space needed for individual feeding. For group feeding each feeding space is allowed for every 3-4 pigs with pens accommodating up of 20 pigs and each space per 4-5 pigs with pens of over 20 pigs.

16.5 Types of Pig Sties

There are different types of pig sties generally constructed for housing of different classes of animals:

16.5.1. Grower/ Finisher Pen

In this system, a central feeding alley along with feeding troughs on each side of the passage, associated with pens of 3 m X 1.80 m deep are provides. These pens would accommodate 15 pigs up to 40 kg, 10 pigs between the weight group of 40 to 90 kg and 8 pigs of over 90 kg weight. In the summer months, it is preferable to reduce the number of pigs. Pen walls should be made up of solid wood or concrete of about 60 cm height to prevent pigs from fighting between pens. Above this point tubular steel is preferable. Controlled feeding is important to ensure the best possible feed conversion efficiency and production of high quality pigs. Feeding trough should be made of concrete or water resistant material. The automatic water drinking device would ensure the constant supply of fresh water. The model grower/finisher house is shown in Fig.16.5.1.1

16.5.2. Farrowing House

Special pen layouts are required for farrowing sows. The

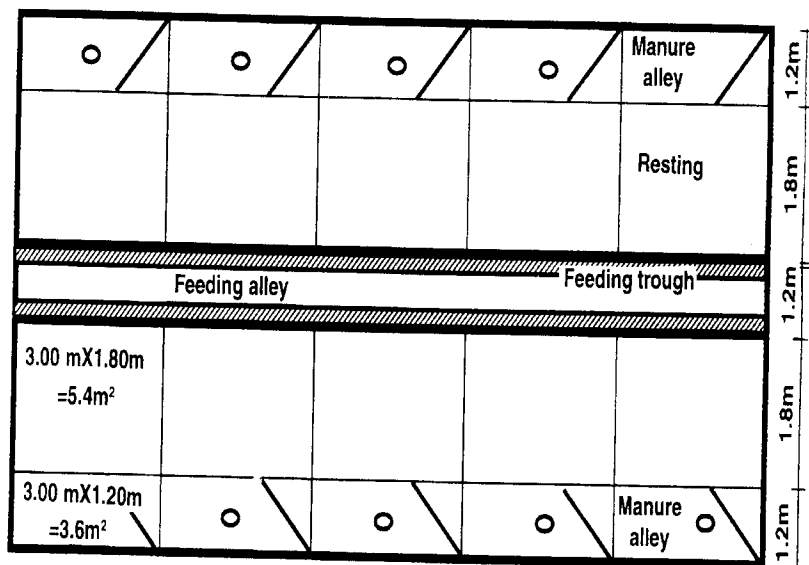


Fig..16.5.1.1 A Layout of Grower/Finisher Plan

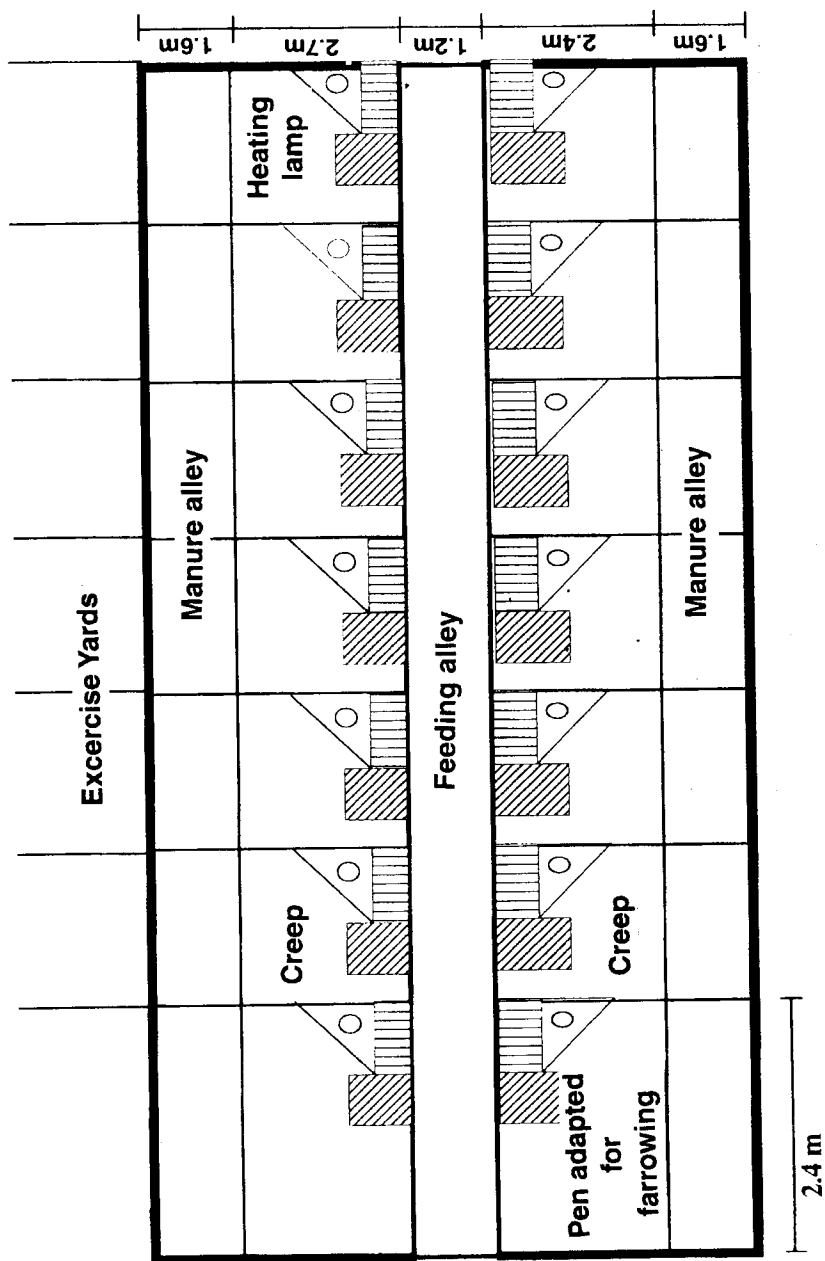


Fig.16.5.2.1 A Plan of Farrowing House

aim of farrowing pen design is to provide comfort for the sow and as a measure of safety, warmth and free access to food for the piglets. A farrowing crate or a set of guard rails are an aid in saving small pigs. The rails should have enough space to allow the sow to lie down comfortably and to expose both row of teats. Infrared heat lamps are the best source of brooding heat. The heat lamps can be arranged in one corner of the pen. The farrowing pens are 2.40 X 2.70 m with a 1.6 m alley. These pens have guard rails 25 cm above floor level and 25 cm from the pen wall to protect piglets from being crushed. It is always advisable to provide some bedding materials such as straw to increase the comfort of the animals. The model farrowing pen is shown in Fig.16.5.2.1.

16.5.3. Housing of Gestating Sows

In this system of confinement housing, the sows can be individually fed both during gestation and immediately after weaning in order to improve the reproductive performance. The gestating pen should not be less than 2.4 m X 2.5 m. About 4 to 5 gestating sows can be grouped in pens, according to the age and size of herd. The model housing for gestating sows is shown in Fig.16.5.3.1,

16.5.4. Housing for Boars

Boars may be housed separately in pens closed to sows. The size of the pens should be 2 m X 3 m with exercise yard of 4 m X 3 m. Along the back of the pens, there should be fenced area with a concrete floor for daily exercise. The model housing for boar is shown in Fig. 16.5.4.1.

16.5.5. Combined Housing

For smaller units with less than 50 sows, specialized building for the various stages of production may not be practical or desirable. A universal pen 2 m wide and 3 m length can be used for one sow with her litter or for one boar. Three to four gestating sows or 6 to 7 growing/ finishing pigs of up to 90 kg can be successfully housed. When used for farrowing, the pen should be provided with guard rails or a farrowing stall and creep with heating or a portable wooden crate for the piglets.

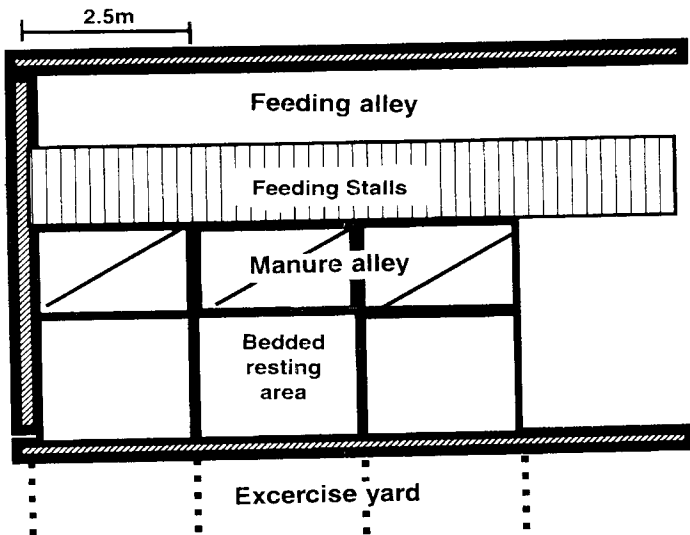


Fig. 16.5.3.1 Housing Plan for Gestating Sows

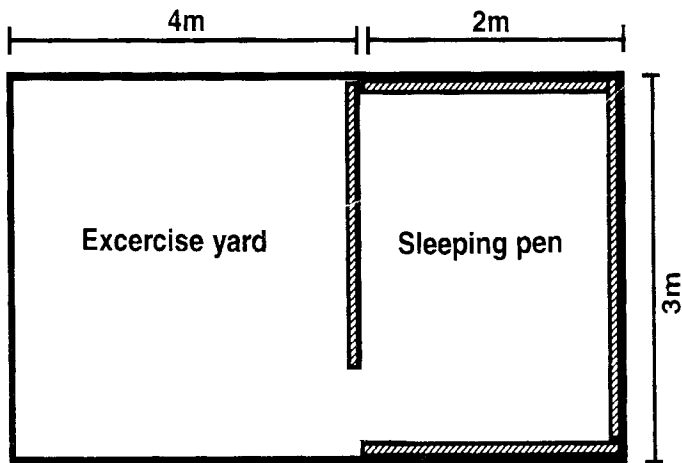


Fig. 16.5.4.1 Housing for Boar

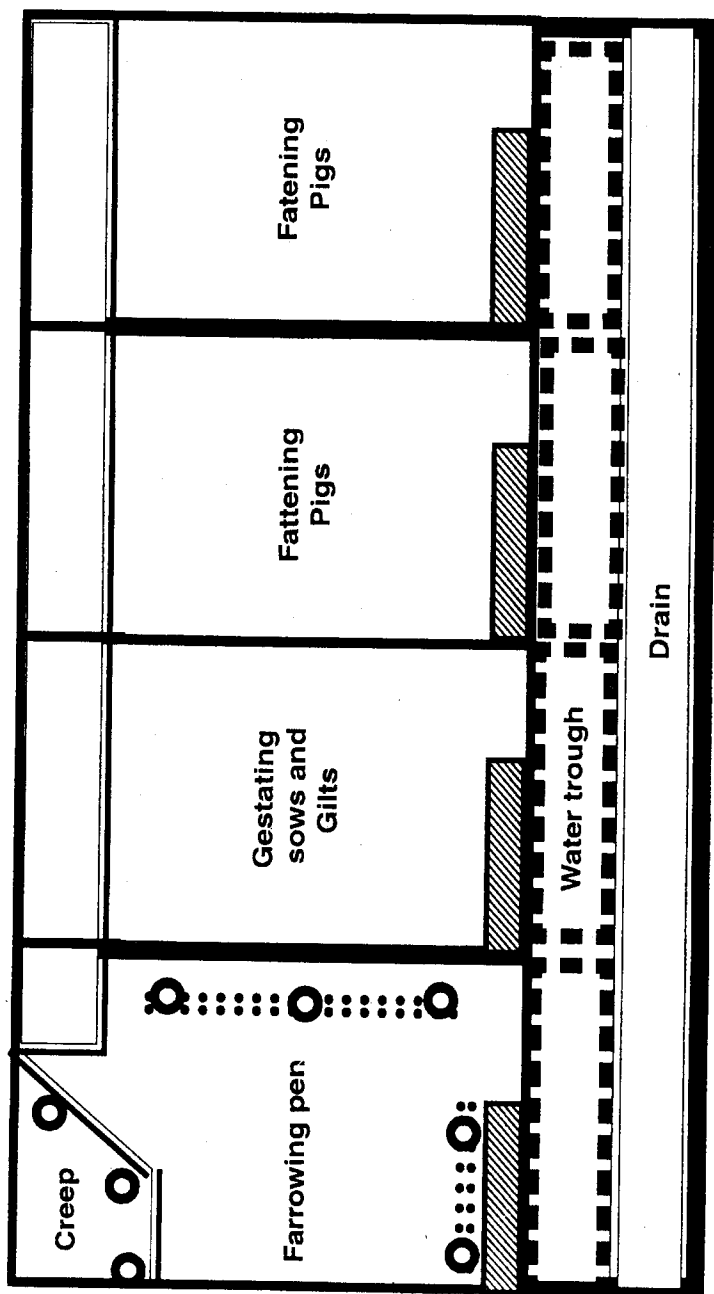


Fig. 16.5.5.1 A Combined Housing plan

Combined housing provides a high degree of flexibility but does not prove an efficient use of building space in comparison to specialized units. The model combined housing plan is shown in Fig. 16.5.5.1.

16.6 Housing to suit different climatic conditions

There is a need for different type of houses are to suit different types of climatic conditions for efficient pig production. When the natural environment is outside the range of the pigs various device can be used to modify the environmental conditions to make it more suitable.

In winter season, the open windows may be covered with screens which may be made up of fabric, canvas or woven with leaves or corrugated iron or asbestos. This will help to reduce the air movement through building and retain more of the heat produced by the animal. The screens should be completely removable, because they can be partially deployed in change of weather. In places where night temperature falls the pigs require supplementary heating either by lamps or by heaters.

In summer season, when the temperature rises above the comfort zone, additional cooling is needed. It can be provided by the following ways:-

1. All screens should be removed. Increase air movement through the open side of the buildings will help in reducing the temperature.
2. The roof should be painted white on outside and black on inside. Hay, straw or other plant materials gives excellent shade.
3. A spray or a wallow can considerable reduce heat stress in pigs. Wallows, which are simply small troughs of water can be made of brick, concrete etc. The drainage and cleaning is very important from health point of view. Sprinkler methods of watering have produced better results to keep the temperature low as they are evenly distributed amongst all the pigs. It is also hygienic and requires less water, not occupying pen space and can be operated as and when necessity arises.

4. Cooled drinking water may effect on growth and feed conversion efficiency.
5. Evaporative cooling is helpful in areas with low relative humidity. It consist of exhaust fans arranged to take fresh air through a wet pad.

16.7 Low-cost housing for tropical and subtropical Area

The scientific system of raising pigs should be based on the practical approach of the local needs, using the cheaper and locally available housing materials.

16.8 Housing Systems for Pig Production

16.8.1 Housing for Scavenging System

The traditional pig keepers belonging to socioeconomically backward class of the society are compelled to follow old and primitive method of pig rearing. Under scavenging system, pigs are allowed to loose and fed on scavenging materials. Only shelter during night time is required and no specific building is required and pigs are kept in kaccha rooms of mud and grass and can be easily made by locally available material.

16.8.2 Housing for Outdoor System

Outdoor system are an attempt of pigs rearing in a modified way of scavenging system. Pigs are generally kept in a strong enclosures either made of wood or strong fencing materials. This system requires a large area for free movement of pigs. Small wooden houses are also provided within the enclosures for shelter. Pigs are allowed for rotational grazing and small quantity of balanced ration after provided. No systemic breeding is practiced and sow for farrowing are shifted to a movable farrowing pen. Pigs reared under this system helps in increasing the fertility of the soil due to their habit of digging soil and passing excreta.

16.8.3 Small Scale Indoor Housing

In this system only small number of pigs are kept ranging from 2 to 10 in house made of wood and bamboo. No cement or concrete is used for construction of this type of house. The pigs are fed with kitchen garbage and feed. This type of construction is being practiced successfully in North-eastern region. The



Fig.16.8.4.1 Intensive Indoor Pig House

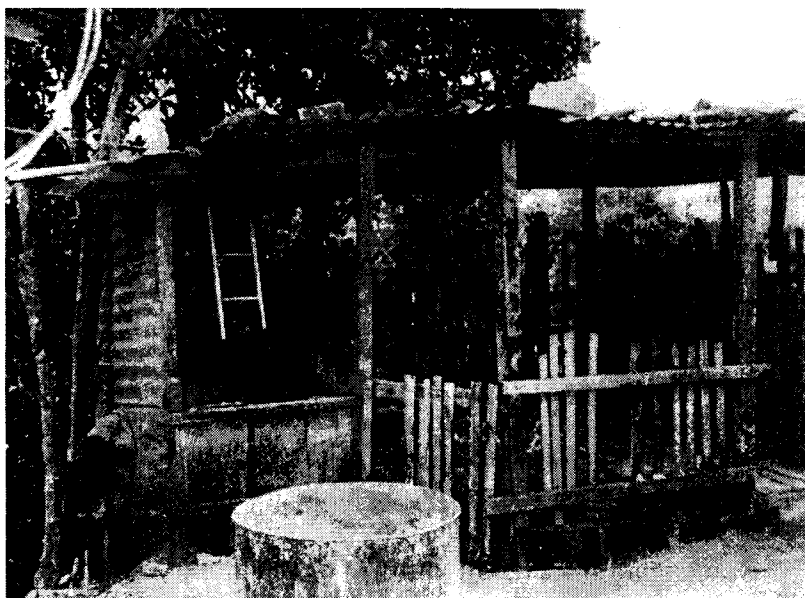


Fig. 16.8.3.1 Small scale Indoor Pig House

ventilation is natural and pigs are healthy (Fig. 16.8.3.1).

16.8.4 Intensive Indoor Pig House

This type of housing system is suitable for more than 10-20 pigs. Different types of buildings are constructed for various stages of life cycle of pigs. Some time similar rooms are constructed and provision is made for changing into special type of housing needs. A scientific design is essential for profitable pig farming (Fig. 16.8.4.1).

This system of pig raising has gained popularity. The pigs are housed in a small area hence expenditure on labour, health cover, and other physical facilities are increased. The efficiency of feeding and management results in production of quality pork and pork products.

16.9 Ventilation and Climate Control

Carefully planned ventilation is an important key in controlling climate for profitable pig production. The expired moisture is about 3 gal./1000 lb. body wt./at 50°F, it should be removed for decreasing the possibility of spread of infection. It is essential to have proper insulation of the building for effective ventilation. The insulation is measured as R-value, which is a measure of resistance to the passage of heat. If higher the R-value better the insulation. R-value of about 15 for walls and 25 for flat ceilings is recommended. The windows have low insulation as compared to walls, hence the area of windows should be minimized to reduce the heat loss. A typical modern ventilated pig house is shown in Fig. 16.9.1. The pigs are healthier under proper ventilation (Fig. 16.9.2).

There are two main parts of good ventilation systems, the fresh air inlet system and the exhaust system.

Objectives of Ventilation

1. To remove expired moisture to dilute the pathogens.
2. To dilute the pathogens shed by the pigs.
3. To maintain reasonably uniform temperature in winter and cooler temperature in summer.
4. To prevent bad odour circulating inside the shed.

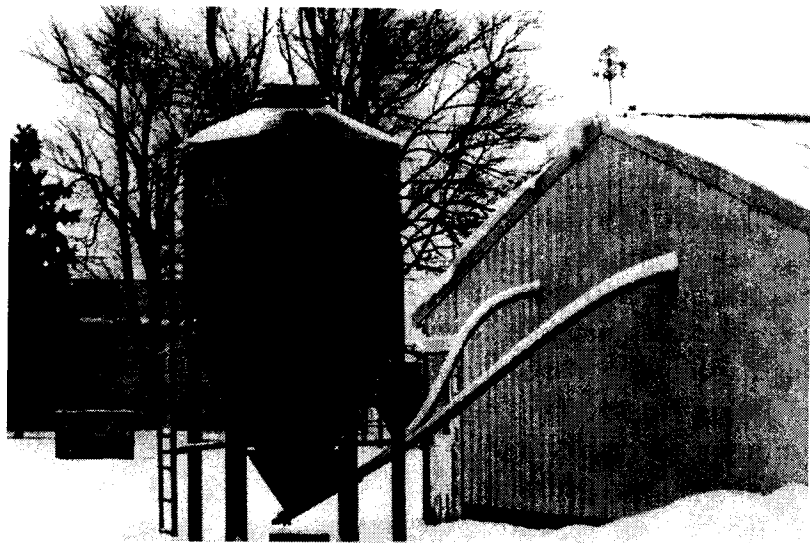


Fig. 16.9.1 Modern ventilated Pig House.



Fig. 16.9.2 Pigs under proper ventilation.

Fresh Air Inlet System

A fresh air intake system that will distribute incoming air uniformly is essential. It must have sufficient capacity to prevent the negative static pressure in the building. High static pressure is an indication of resistance to airflow. If the sound of fan changes when the door is open, there is an inadequate supply of fresh air entering in the building.

Exhaust system design

The determination of a ventilation system's winter capacity for moisture control should be calculated on the basis of weight of the pigs housed. Fans used for pigs shelter ventilation should be designed specifically for that purpose. All fans should be certified as being capable of delivering the required air flow, i.e. 0.3 cm static pressure, which is approximately equivalent to the pressure created by a 24 km per hour wind blowing against the operated fan. Wind substantially affects the output of ventilating fans by resistance to airflow. As a rule, properly selected single speed exhaust fans should be used.

Natural Ventilation

Natural ventilation is accomplished by the forces of nature, i.e. wind and gravity. No mechanical equipments are use, except for circulation of air in hot summer days.

Since the force of gravity is a primary mover of the air through the building as warm air rises and cold air falls. In buildings with a gable roof there be a continuous, unobstructed opening at the peak 2 in wide for each 10 feet of the building width, and the full length of the building. The pig house should be oriented on an east-west axis. They must have a south side open with continuous, adjustable ventilation openings in the north wall. The permanently fixed openings to permit minimal air entry can be provided by leaving the space between the top of the plate and the underside of the roof open.

The buildings are located in areas subject to heavy winds, closure of even these openings on the windward side may be necessary under extremely adverse conditions.

16.10 Air-conditioning of Pig Breeding House

Air-conditioning of pig breeding house is essential when the stock is maintained for pure breeding. In India the cost of two month old breeding male and female of exotic breed i.e. Large White Yorkshire, Landrace, Hampshire amounts to Rs.25000 to 50000/ animal. This is a good practice to maintain these valuable stock in either houses installed with window air-conditioner or split air conditioners. For a house of 150 square feet, 1.5 ton window air-conditioner is adequate. This house can be used for breeding boar and sows.

17. IDENTIFICATION OF PIGS

Identification of pigs is very important for pig breeding farms. However, identification is also necessary for effective feeding, management and production performance of pigs.

17.1 Why Identification?

Individual identification of pigs is most necessary for breeding herd. The identification of fattening pigs is also necessary for the effective control of production system. Identification is very important for insurance of pigs.

An essential part of good identification is to make sure that all equipments for repeated use on pigs are kept clean and sterile.

17.2 Methods of Identification

The basic requirements for permanent mark includes, a mark which can be read easily at a distance and easy and painless to apply to the pigs.

17.2.1 Ear Tags

Ear tags are made of plastic or metal and available in different colours. There are a vast range of makes and product type available as one-piece or two-piece devices. They can be pre-printed in the factory or can be supplied as blanks on which the herd operator writes his own codes. A flexible polyurethane plastic device is less likely to catch and detach than one of the rigid plastic.

Colour

Yellow colour with black code or mark is more visible and suitable. If the colour of the tag is darker, white marking would be easily visible. Try to choose a tag which does not fade with prolonged exposure to light. Double tagging in both the ears with different colour tags is advantageous.

Preprinted tags are more expensive but often easier to read. However, blank tags also plays an important role in replacement of lost tag. A special pen or ink is essential for permanent mark on blank tag, which would last the life time of a sow, i.e. up to 5 years. The size of the tags should be just sufficient to hold the markings. A 20 mm high and 13 mm wide can be identified at a

distance of 5 meters. Very large tags can be less secured and may be readily chewed by the pigs.

Advantages:

1. Available in plastic or metal.
2. Metal tags are usually made of aluminium, are cheap and easy to fix and durable.

Disadvantages

1. They are more likely to pull out.
2. Due to their small size, it is often difficult to read, specially once they have become soiled.
3. Ear wax and lanolin from the hair and dirt in the pen are inevitable factors affecting legibility of tag in the ear.

Method of Application

Products of the two-piece variety are applied by using either special pliers or a U-shaped autotagging applicator which incorporates a piston to push the 'male' segment' through the ear.

Single-piece tags are fixed by using knife applicator either in the shape of flat blade or of a hollow circular blade that punches out a hole for the tag shaft (Fig. 17.2.1).

Pigs should be restrained by using snout tether to avoid sudden movement of head, which may lead to rupture of blood vessels. The tether is a running noose which is placed around the snout and then pulled tight. The pig will stand steady with little movement of its head.

17.2.2 Tattooing

Tattooing is widely used for both breeding stock and slaughter pigs. It can be applied to the young pigs. It also offers the possibility of multi-line and multi-digit marks. Its cost is also very low. A tattoo applied at one month old pig would be visible at 6 month age. A well made tattoo may remain readable for the lifetime of the breeding sow. A good mark is made only when the needles are clean and fully impregnated with the antiseptic paste or ink.

Tattoo numbers vary in size from 8 mm to 18 mm. For very young piglets 8 mm, 9-10 mm for weaned piglets and 18

mm for sows' ears are suitable for proper marking.

Black ink is suitable for clear mark on the ear of white pig, however green ink is preferable for black or coloured pigs. Extra ink or paste should be rubbed into holes after application of the tattoo. Care should be taken to keep the mark away from the edge of the ear.

Make sure that the needles are sharp and not missing and individual character blocks up to 4 per hammer are present in correct order. The blocks are mounted in reverse sequence and appear to be back-to-front. It can be checked by pressing the hammer face against a piece of card or holding it up to a mirror.

Machine operated needle systems are more suitable than manual. A modern pair of a tattooing forceps, spring loaded and equipped with an automatic release mechanism after marking is good. A American designed rotary-head tattooer, that has needles for the characters 0-9 mounted on an endless chain. Numbers can be changed by turning each chain in a way similar to date stamping machine. The main advantage of this machine is that number loss can be prevented.

17.2.3 Ear Notching

It is the oldest, cheapest and most permanent method of marking pigs. It involves cutting a series of v-shaped notch of pieces of skin of each ear. With the help of clipping forceps, V-shaped notch of skin can be removed from piglets, soon after birth. There are two recognized system of ear notching, i.e. British and American. One disadvantage of ear-notching is that abnormally high number of notches per ear may be required in a large herd.

17.2.4 Ink Marking

Ink marking or painting on the back of sows are useful for temporary identification in the breeding herd. The identification number can be easily marked on his back using purple-coloured silver nitrate paint. The mark normally lasts for 6 months, and the main advantage of this method is that the paint colours only the hair, not the skin.

17.2.5 A Slap-mark on the sow

It is a tattoo mark by using a slapping action of the hammer against each side of the gilt's neck- on the almost hairless patch of soft skin behind the ear. The number is clearly visible and less likely to be obscured by soiling of the body, as it is present on the portion of body, which tends to keep the most clean in practice. The gilts receives no discomfort, and the number would last for the breeding life. The equipments which are required are the tattooing hammer, interchangeable needles and ink pad.

17.2.6 Electronic Identification Devices

Computer science has evolved an electronic system of good identification. The slightly thicker tag in the sow's ear incorporates an electronic transponder with its own power source to signal her identity to a nearby sensing unit.

Collars which bears not only a visible number but also a small box which can signal the pig's identity to a computer sensor for automatic feeding and computerized management.

A electronic tag is a tiny electronic device, is small enough for attachment to a tag. It contains a long-life lithium battery, weighing about 19 to 20 grams and can be read a distance of one meter. Its integrated circuit is pre-coded with the numerical identity of the individual pig.

The cost involved in electronic implants is very high, but it would be cheaper in the near future. The next generation of identity signalers could be made as small as a cereal grain for implantation under the skin.

17.3 Equipments- A Key Factor in Production

The equipments makes to a rigid program of sanitation for efficient pig production. Equipments should be designed for efficient use and for economy of labour at every point where it can be done. The proper kinds of equipment provided in suitable amounts and used effectively make a definite contribution to keeping costs low.

The equipments includes pens, movable houses, farrowing pen, guard rails, farrowing crates, brooders, feeders, sprinkler system for cooling, drinking system, feed handling and storage

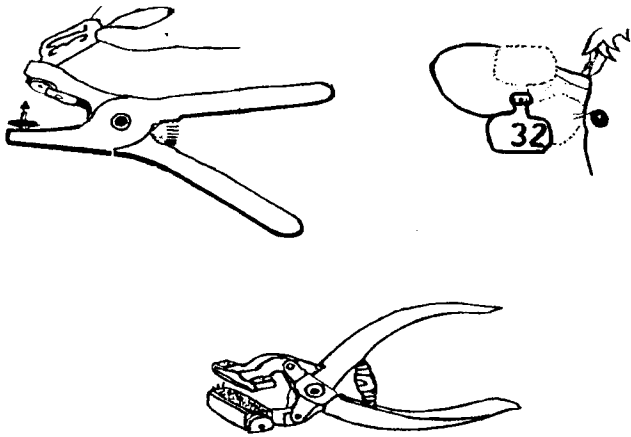


Fig. 17.2.1 Ear tagging machine and tattoing forcep.

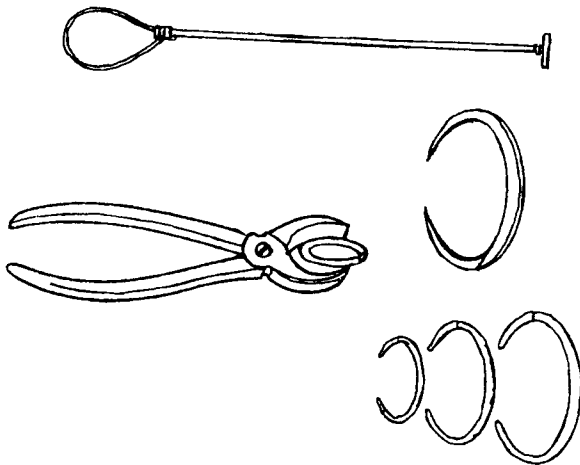


Fig. 17.3.1 Nose rings and controlling device for boar.

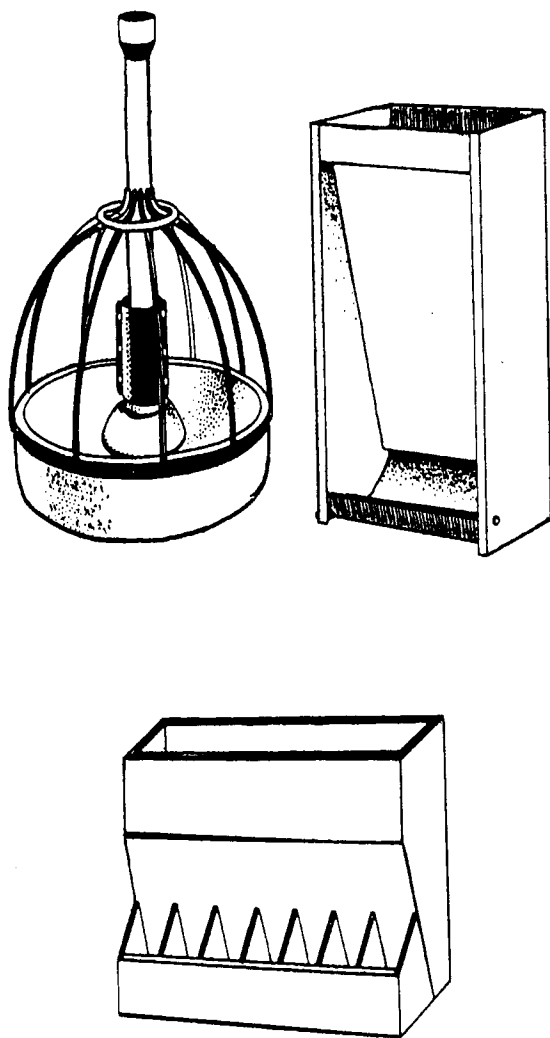


Fig. 1.3.2 Feeding equipments for pigs.

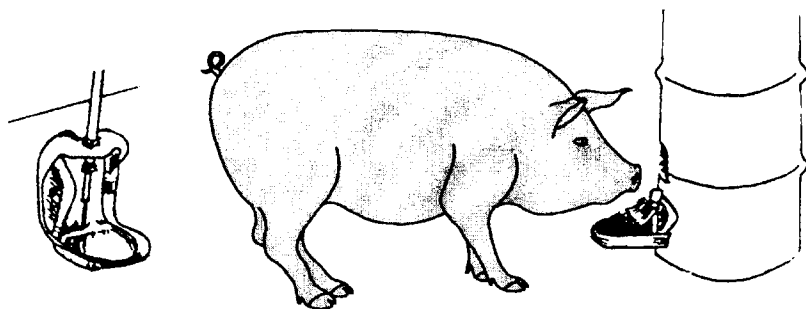


Fig. 17.3.3 Feeder for pigs.

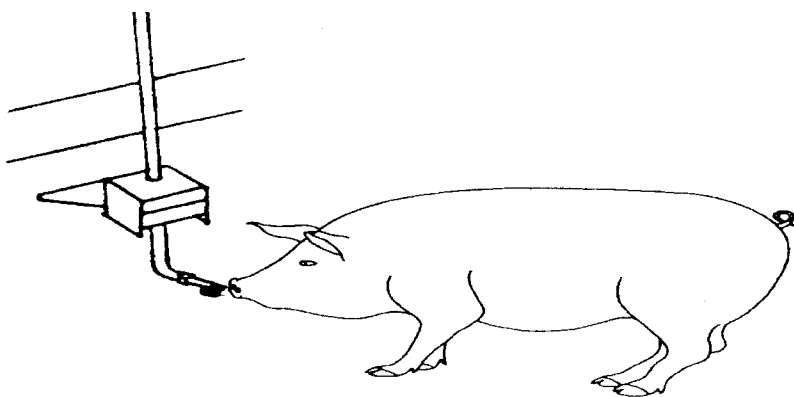


Fig. 17.3.4 Waterer for pigs.

system and equipments for waste disposal. Some of the important equipments are shown in Fig. 17.3.1, 17.3.2, 17.3.3 and 17.3.4.

Whatever equipments which are used for pig farming should be substantial in both material and construction. So that it can with stand the prodding of the pig's powerful snout and the pressure of their heavy body. The construction must permit easy and complete cleaning for maintenance of good hygiene and sanitation.

18. MANAGEMENT OF PIGS

The management plays an important role in pig farming and it provides the conditions which permit the animals to function to the maximum of their capacity. The management includes daily routine handling the animals within the limitation of the conditions. Planning and modification will increase the effectiveness of management.

18.1 Management of Breeding Herd

The breeding herd offers greatest reward for good management. The good management of breeding herd solves problems of breeding, sterility, gestation, farrowing and lactation. The skillful management of the breeding herd increases the savings. These savings are carried all the way through the production cycle and show up best economic return at market times as extra profits. The breeding herd are maintained for two purpose, i.e. to produce pigs for the finishing pen and to provide replacement stock of breeding animals. The cost of maintaining a breeding herd on the average farm accounts for approximately one third of the total cost of producing pork.

The duration of gestation and lactation of the sows can be combined in such a way that they produce two litters of pigs a year. The performance of gilt and sows differs. Sows, on the average, farrow one or two more pigs per litter than gilts do, but gilts raise a larger percentage of the pig they farrow.

The size of the pig enterprise can be enlarged either by increasing the number of farrowing sows at a given time or by increasing the number of the farrowing periods in a year. The confinement rearing and automation in pig industry will reduce the cost of labour. The system of rearing should be chosen according to the size of the farm. As specialization and size of the pig production units increased, confinement systems will become increasingly important.

The farrowing dates influences the profits in pig industry. If piglets are born in severe weather, their chances of survival are greatly diminished unless supplemental heat is provided by the use of heat lamps, pig hovers and farrowing crates.

The litter size is also influenced by breed, strain, nutrition etc. The age of the sow has the greatest influence on the size of the litter farrowed. The number of pigs per sow farrows per litter increases with the advancement of age until the sow is about 2.5 to 3 years old, remains approximately constant until she attains 5 years of age and then gradually declines. The breed differences in the number of pigs farrowed per litter exist. The Large White Yorkshire and Middle White Yorkshire excels all other breeds in the size of litter farrowed.

18.2 Management during Mating to Pregnancy

The gilts are to be kept separately from the boars to avoid accidental breeding. They may be observed for oestrous. The signs of heat is recognized by the willingness of the female to accept the male. The boar can be used for detection of heat. The optimum time of mating is 10 to 20 hours before ovulation to maximize conception rate and litter size. Two or more mating are required to increase the size of litter. The contact with mature boar should be direct by allowing a boar into the pen for at least 15 minutes each day under supervision. A better response will be obtained by leaving the boar for 24 hours per day with the gilts for the first four to five days until the first gilt show signs of coming into oestrous. At this stage, the boar should be removed and can be introduced to the gilts for a short period under supervision. After showing the first heat, the gilts should be flushed for 10 days prior to the heat number at which the gilts are to be served. As soon as the gilts are served, high level feeding should be discontinued so as to minimize embryonic losses. Three weeks after mating every gilt or sow should be checked for signs of oestrous. If, the signs of oestrous are not seen, the gilt or sow should be housed separately. They should be normally given a constant intake of feed and ration and should be increased during the last three weeks. The average gestation period of swine is 114 days. Approximately after 105 days post-conception, the sows or gilts are moved into farrowing pens.

18.3 Management during Farrowing and Suckling

Management during farrowing and suckling reduces the

percentage of losses from death of the piglets. The farrowing house should be cleaned and ready for use several days before the sows are due to farrow. The sow should be placed in farrowing stall a few days before with a view to familiar herself with the new surroundings. The house should be clean, dry, relatively warm and well ventilated. After the cleaning of the pen, it should be sprayed with a good disinfectant. A 2-3 % of the saponated solution of cresol is very effective. Equipment used in the pen should also be cleaned and sprayed. The sides, underline, feet and legs of the sow should be brushed and washed with a soap and warm water before she is placed in farrowing pen. Entry of visitors into the farrowing house should be restricted.

Coarse ground corn cobs, wood shavings, fine straw or sawdust may be used for bedding. The bedding should be kept clean, dry and well distributed. Removing the sow from the pen each morning and evening for brief exercise, helps to keep the pen clean and dry. The guard rails, made-up of metal pipe should be installed several days before the sow is due to farrow. The guard rail should be placed on the three back sides of pen about 8 to 10 inches from the wall and 8 to 10 inches from the floor.

The temperature in the farrowing house should range from 50 to 50 degree. When temperature drops below 50 degree, the little pigs chill and may catch cold. The use of heat lamps or pig brooders is recommended. The infrared heat lamp type of brooder usually consists of a drop card with a mechanical support, a socket, a heat bulb and a protective reflector with a screen over the end of the reflector. The bulb should be a 250 watt lamp. The unit should be placed about 30 inches above the top surface of the bedding. The brooders should be installed several days before the sows are expected to farrow.

Most sows farrow within 24 hours after milk develops in the nipples. In colder months the piglets should be placed under the brooder or heat lamp. The piglets should be returned to the sow to suckle mother's milk as soon as possible. Each piglet will normally suckle for two to three hours. Weak piglets

incapable of sucking mothers milk should be nourished with due care to regain their health. Bottle feeding can be practiced in case of agalactical condition of the mother. Sows may have difficulty at farrowing, it is best to have a veterinarian to render assistance. Some times the naval cord is long and it should be cut with the help of a scissor or blade after properly disinfecting with tincture of iodine or antiseptic solution like dettol, lysol, weak solution of potassium permagnate etc.

A sow, when fed a good ration may produce from 3 to 4 kg of milk per day. The sow must receive feeds containing important nutrients in sufficient amounts to produce the milk required by the litter. After farrowing, it should be observed at every piglet is getting required quantities of milk. If not, the piglets should be artificially fed on cow's milk. But this is a laborious business. A much better way is to foster them onto another sow. This may be another sow which has farrowed approximately at the same time but the foster mother must have spare teats.

18.4 Pre-weaning Management

Some producers find it necessary to cut piglet's teeth or dock their tails. Piglets have needle sharp teeth which can cause injury to the teats while sucking mother's milk and during fighting to each other. Both teeth cutting and docking are done with a pair of wire cutting pliers often called side cutters. These are sterilized in antiseptic solution before and between uses. Tails are treated in antiseptic after cutting.

Pigs are castrated at the age of two to four weeks, by open method of castration on the scrotum.

18.5 Management from Weaning to Market

Piglets are generally weaned at the age of 8 weeks. There are certain advantages of early weaning. With the use of fortified pre-starter, starter and grower rations, it is possible to wean the pigs in advance. Early weaning will reduce pre-weaning percentage of mortality, prevent losses in weights of the sows and permit earlier re-breeding of sows. Less floor space is required when the pigs are weaned early.

The husbandry of pigs from weaning to slaughter is easier

and simple. The main problems are to insure a high feed intake, specially during the early phase and avoid problems of over crowding, uneven groups, bullying and other vices. Pigs from different litters can be mixed after weaning. Most pigs should be fed *ad libitum* at least in the growing stage till attaining live weight of 50 kg or more, depending on their feed conversion efficiency and carcass quality requirements of the chosen market. One feeder space should be provided for every three pigs.

18.6 Stress Management

Stress is a difficult concept to evaluate in terms of its effect on animals and on the pig production and pork products. It is well established that stress does profoundly affect the biology of pigs and it lead to low productive efficiency. In particular, reproductive performance is adversely affected by varying stress levels and this manifests itself as: reduced litter size, failure to show oestrous, poor conception rate and sporadic puberty attainment.

Stressors or the factors causing stress in sows and gilts come in a variety of ways. Nutritional stress is perhaps one of the easiest to define and over or under nutrition can be judged against published nutrient requirements.

Social stressors are more difficult to understand but things like overcrowding with both high stocking densities and large group sizes are best to avoid. Other stressors for pigs desire from; relocation, mixing, environmental temperature and a whole host of management factors related to the system of production. One of the most important stressors may come from the man-animal interactions which exist on individual farms. On some farms the level of stockmanship could be very high indeed and all animals are well cared for as individuals. On other farms there may be nothing wrong with the overall system of production but because of unusual interactions between the pigs and the people involved with the animals, the pigs could be faced with considerable stress in their lives.

All of these factors represent a change in our circumstances with all the problems that are associated with these changes.

The medical profession use such ranking lists to compute the likelihood of a disease situation (physical or mental) being due to one or a combination of these stressors. The key may be in particular bad combinations of all of the stressors leading to disease. It is therefore highly probable that similar lists could be drawn up for pigs.

If individual farms as a part of the system overload the animals with too many adverse stressors at once then the outcome is a collapse of the immune system in small piglets and the reproductive system in both females and males. At the present time it is hard to pinpoint the danger signs of stress on a pig farm. Non-specific poor reproductive performance is one of the signs but it is not always easy to allocate the blame. Other signs are stereotropism or displacement activity. These behavior patterns in pigs are seen outwardly as "*bar-biting*" and as vices such as tail-biting in young pigs.

In older animals, it could also reflect hyper-aggressive behavior or poor maternal instinct. There seem to be particular times in the normal reproductive life of sows when they are especially prone to stress. These are during the major events such as; puberty, weaning, mating and farrowing. At these critical stages perhaps animals should be treated with extra care. However, it is pleasing that there are now a number of research projects being carried out in different corners of the world on the effects of stress although the impetus for this work has been the encouraging is that good welfare goes hand in hand with a high level of productivity and so by considering the welfare of their animals pig producers could also increase their efficiency and hence their profits.

In physiological terms the connections between stress and reproduction are becoming much better understood. Stress for example is known to elevate the blood hormone cortisol and this leads to cascade of events culminating in the formation of cystic ovaries. This extreme case shows how via the disruption of hormonal events, stress can modify the animals ability to have normal oestrous periods and also alter the ovulation rates

and the ability of fertilized eggs to survive the first 3 weeks of pregnancy.

18.7 Management for Environment Control

Controlled environments constitute a range of technology scarcely tapped for pig production. Environmental stresses, especially those of high and low temperatures have a marked affect on pigs. They change the rate at which they grow, reproduce, or accomplish their desired functions of pork production. Temperatures not only influence directly on pig physiology but indirectly on forage production, parasites, diseases and soils. Pig has a narrow temperature range under which it will perform most efficiently. Environmental structures and feeds should be altered to adjust the limitations of temperature.

Controlled environments will become the rule rather than the exception for pig production. Improved housing providing environment control for pigs plays an important role for increasing reproductive efficiency performance and disease control and for improved feed utilization in pork production.

18.8 Management for Control of Diseases

The disease is another major factor which may reduce the number of pigs farrowed. Any infectious disease or low-grade infection of the genital tract of the sow may prevent conception. Even if conception takes place, infection may terminate into abortion.

19. BEHAVIOR MANAGEMENT OF PIGS

The study of knowledge of pig behavior can provide a basis for determining their “rights” and to ensure that their care and husbandry will not jeopardize their overall physical and psychological well-being. Certain decision of principle have to be made about the acceptability of practices connected with pig husbandry and about environmental conditions in which pigs are kept.

The productive performance of pigs is not an absolute guarantor of welfare; the economics of space and scale often expose individual welfare in order to maximize overall production.

19.1 Behavioral Characteristics of Pigs

The pig has been subjected to the most intensive conditions of all farms mammals. The wild boar is present in several parts of the world. The pigs live in small family groups made up of the sow and her associated litter. It is an omnivorous animal, eating roots, vegetables and carrion and lives in scrubland or light forests. It has a streamlined body for pushing through undergrowth. Pigs smelling and hearing power is more well developed than vision and have a range of vocal calls. They are able to locate odorous with ease and they fight with strange pigs, particularly in mating season.

Pig is sensitive to extreme of climate, as it has no sweat glands, no thick hair cover and relies on fat layers for insulation. Pigs huddle for warmth and wallow to keep cool. They are curious animals using the snout to manipulate objects, very adaptable. They can learn quickly.

19.2 Normal Behavior in Pigs

Animal behaviors is the means whereby the animal mediates dynamically with its environment, both animate and inanimate. Ethology is the scientific study of the behaviors of animals in natural environments. In 1973, three scientists received the first Nobel prizes in ethology.. Those pioneer of ethology were Lorenz, Von Frisch and Tinbergen. Konrad Z. Lorenz as “the father of modern ethology” laid the groundwork

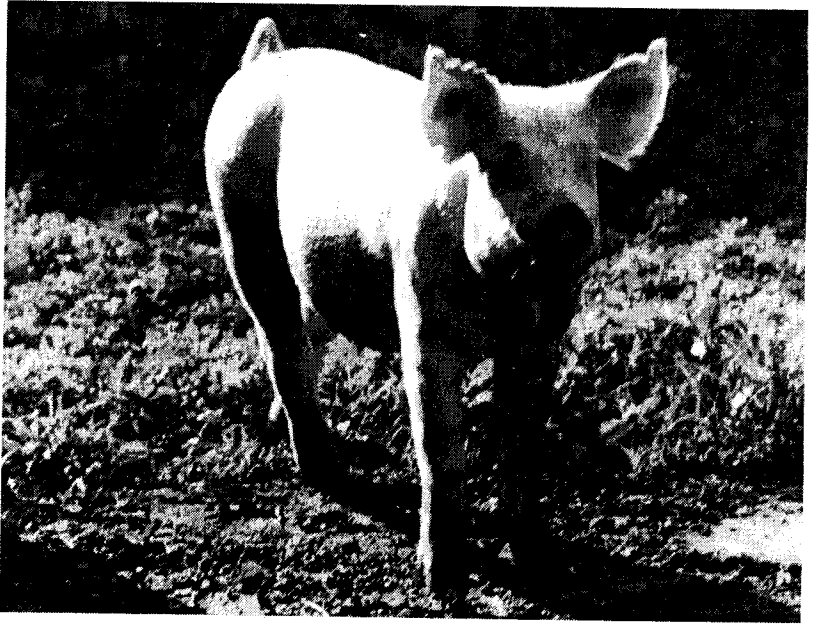


Fig. 19.2.1 Normal behavior of pig.

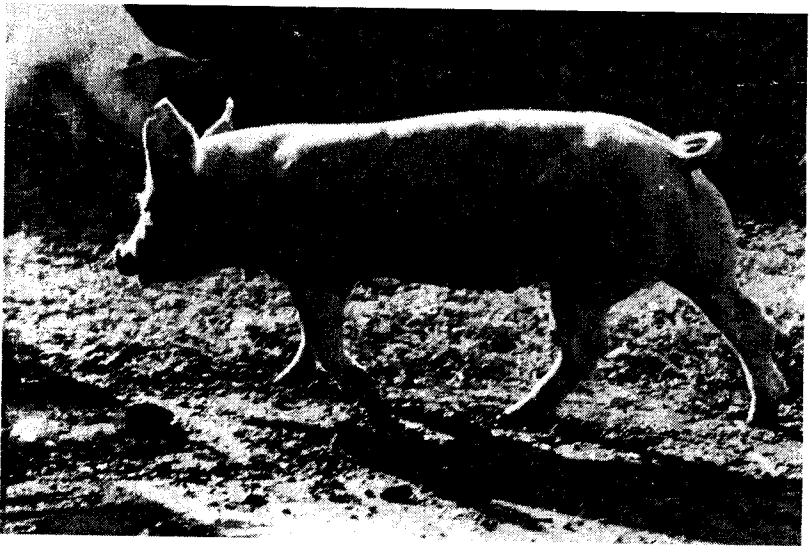


Fig. 19.2.2 A normal running pig.

for many of the most important lines of research still pursued today. Ethology recognizes motivated behavior in animals, such as pain, hunger, fear and anger. Excitement depends upon perception and senses. Pigs have complex behavior and there are several aspects of pig's behavior, which provides a basis for a critical assessment of how pigs are perceived and philosophy and values behind such perceptions. The normal behavior of pig shown in Fig. 19.2.1, 19.2.2, 19.2.3 and 19.2.4.

19.2.1 Kinesis

Young pigs are graceful and able to run about. The mature pig, with its relatively massive trunk, is physically ill-equipped for movement at speed. Well grown pigs therefore run distances of only a few meters. They are, however able to trot at a reasonable speed over long distances.

Pigs have long periods of inactivity each day. During these periods they typically rest in huddled groups. Pigs are active during the night hours, especially in the sows in oestrous. This may be due to feed search behavior of wild pigs.

19.2.2 Association

Pigs in an established hierarchical arrangement are quickly able to recognize an alien in the group. Since pigs are normally kept in groups which are allocated a relatively small area, it is inevitable that many social behavioral exchanges occur and that many of these have aggressive outcomes. The role of aggression in pig production is of considerable importance. By about, two weeks of age, piglets begin to show exchanges of agonistic behavior in the form of brief but vigorous fighting. As a consequence of this, dominance subordination relationship are quickly formed within the litter. New relationship of this kind form each time strange pigs come together, where there is no mixing of this kind. social organization become well established and functional and they reduce aggression within the group. Limited aggression within a group of pigs conserves energy, which is reflected by production. Dominance in the hierarchy ensures that an individual is able to carry out chosen behavior. When competition for food or space increases, aggressive



Fig. 19.2.4 Feeding behavior in pigs.



Fig. 19.2.3.1 Pigs enjoying wallowing.

behavior within the group increases. The build-up of aggressive behavior leads to a weakening of the social hierarchy and, in due course, may cause it to break down completely. Some forms of abnormal behavior in pigs are likely to be associated with pathological increases in aggressive behavior resulting from instability in the social hierarchy.

19.2.3 Body care

Pigs are more susceptible to heat stress. In the presence of high ambient temperature, they are singularly ill-equipped physically to radiate heat. Given access to water, they engage in wallowing activities during which they wet all the ventral areas of the body and give up excessive body heat by conduction (Fig. 19.2.3.1). Under field conditions in warm weather pigs create mud-wallows, wallowing in mud, in addition to permitting heat to be conducted from the body, also causes a reduction in excessive ambient temperatures. The heat stress can be easily controlled by the pigs voluntary wallowing activities. Pigs are ill-suited to extremes of ambient temperature. They receive poor body insulation from their sparse covering of hair. They have very little loose skin from which to radiate excessive body heat and their sweat glands are confined to their snouts. In spite of these physical inadequacies, pigs are able to adjust to temperature extremes through specific thermo-regulatory behavior. Pigs enjoying snow-fall in U.S.A. are shown in Fig. 19.2.3.1.

19.2.4 Piglet Behavior

The ability of newborn piglets to adapt to their environmental temperature is very limited as they are prone to lose body heat rapidly. The behavioral mechanism for dealing with this problem is huddling. From the time of birth, young piglets display huddling behavior as an organized attitude for most of the day. During huddling they lie parallel to each other, often with head and tail ends alternating along the row. Whilst lying closely together side by side, they usually have their limbs touched underneath them. When a group is large, some of the piglets in the middle may overlies others. The huddling activity reduces the quantity of heat loss. Although, this behavior is

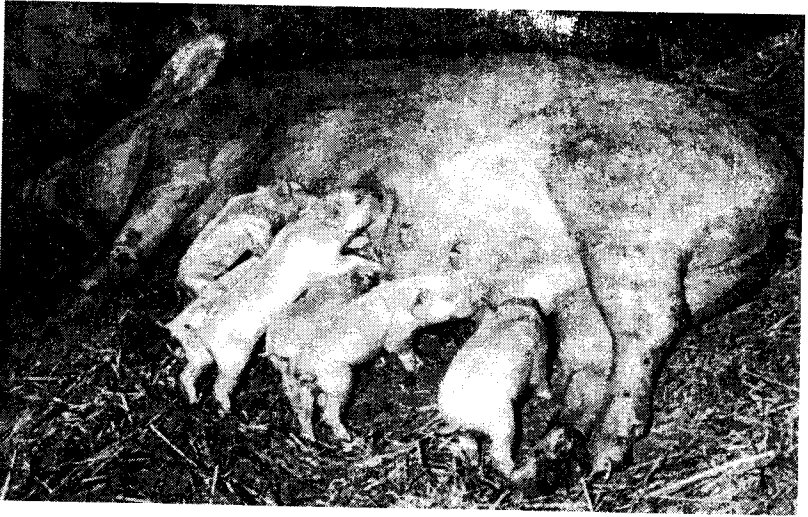


Fig. 19.2.4.1 Suckling behavior of pigs.

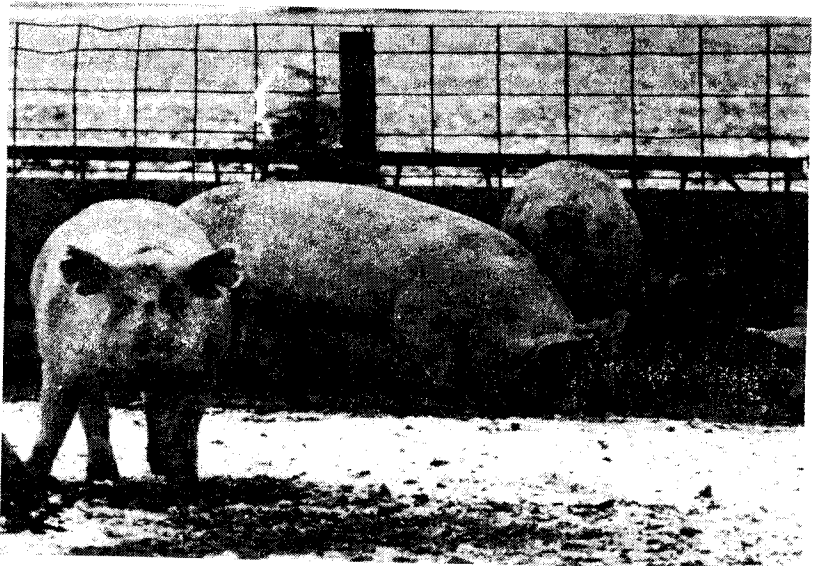


Fig. 19.2.3.2 Pigs enjoying snow-fall in U.S.A.

characteristically shown in the early life in litter, but in adult age, as a means of conserving body heat.

19.2.5 Elimination

Elimination does not take place at random in the pen. Specific sites are chosen by pigs for defecation and urination. In spite of a reputation to the contrary, pigs are extremely clean in their habits, if the system of husbandry imposed upon them gives them the opportunity to express their normal behavior patterns (Fig. 19.2.5.1). Pig premises which are appropriately designed to create dunging areas are usually properly used by pigs. Pigs apparently have a keen sense of territory and even in the most limited quarters, they reserve an area for sleeping accommodation and an area for excretion. The sleeping area is kept as clean and dry as is possible. Under conditions of crowding, it is sometimes difficult for groups of pigs to maintain organized eliminative behavior. When growing pigs are allocated less than 1 m² of floor area each, their eliminative behavior becomes disorganized and uncontrolled. Much of pig's eliminative behavior is learned during infancy from mature animals and if the behavior patterns are not acquired by learning at an early age they may not be acquired at all. Such pigs, in their turn, are unable to pass on learned behavior of this type. These pigs are usually observed to be contaminated with their own excreta and their presence in large proportions in a pig herd is a reflection on the system of management.

Urination, when penned pigs are exposed to high ambient temperatures and their normal behavioral methods of controlling hyperthermia can't operate, it is common for them to urinate in apart of the pen and thereafter to wallow in this line. The passing of small quantities of urine is observed in both sexes during the pre-coital period. It is generally found that pigs excrete close to the source of their drinking water.

19.2.6 Territorialism

The stocking density in groups of pigs is known to have various effects upon their behavior. Social encounters in penned pigs normally take place at or near the feeding trough. These

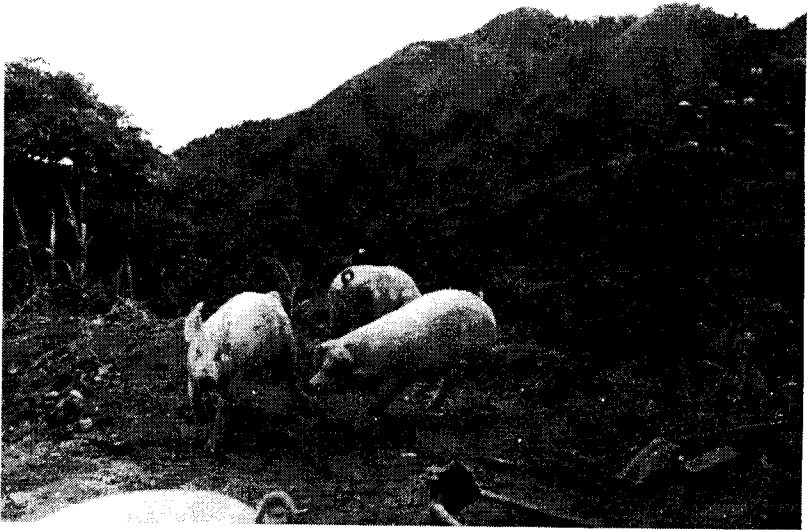


Fig.19.2.5 Elimination behavior in pigs

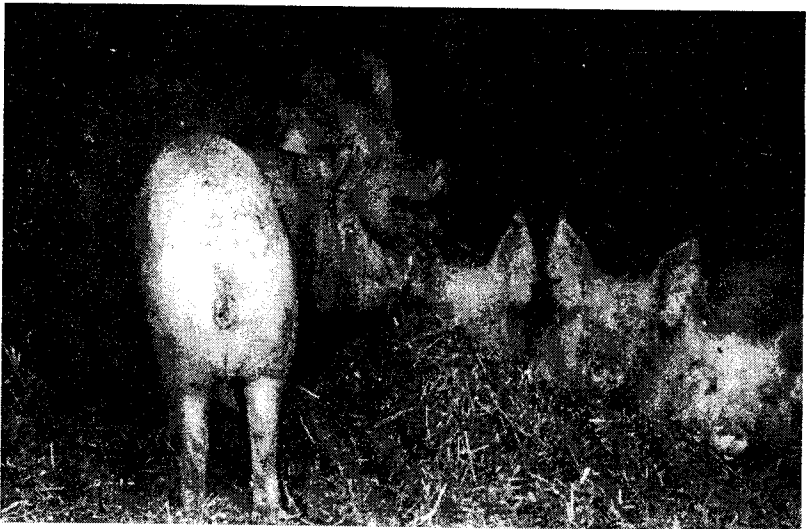


Fig. 19.2.7.1 Resting behavior of pigs.

social encounters lead to clear-cut results when the hierarchical system has previously been well established. When growing pigs are allocated only about 0.75 m² of pen each, there is a rise in severity of social encounters. When the stocking density is any heavier than this it is found that individual pigs, which are low in the social hierarchy, are unable to avoid the consequences of aggressive encounters. In consequence these pigs suffer more injury and reduced feeding opportunities. The productivity of the farm is affected.

19.2.7 Rest

Pigs spend most time resting (Fig.19.2.7.1) and sleeping. Sleeping in groups simultaneously is usual and they are recumbent in rest or sleep of 19 hours each day. Pigs also drowse and about five hours are spent in this state daily. Pigs are characterized by extreme muscle relaxation during sleep. While this is difficult to appraise in a mature sow. Young piglets exhibit profound relaxation. If a sleeping piglet is picked up, it is found to be totally relaxed and evidently in a deep state of sleep.

19.2.8 Vocalization

Among farm animals specific sounds related to specific conditions of age, sex and circumstances. Hunger generates much vocalization notable among piglets and all age group of pigs.

19.2.9 Reactivity

If a strange sow is introduced to an established group of sows, the collective aggressive behavior of the group directed at stranger is likely to be so severe that physical injury may be caused. When two strange boars are put together, they circle around and smell each other and they may paw the ground. Deep-throated barking fronts may be made and jaw snapping engaged, at this point. When fighting starts, the opponents adopt a shoulder-to-shoulder position, applying side pressure against each other. Boars when fighting each other, tend to use the side of the mouth, permitting the tusks to be brought into play as weapons. In this fashion, the fighting boars attack the sides of their opponents bodies. Fighting may continue in this form for

up to one hour before the submission of one animal or the other. Therefore, mixing of adult pig must be carried out with great care. Tranquilizers and aerosol masking odorous are used in commercial pig breeding and other pig farms to minimize agonistic behavior among pigs when mixing them.

19.2.10 Learning Behavior

Pigs quickly learn to drink from mechanical devices which supply water when some plate or button is pressed. Water drinking is influenced by both animal size and environmental conditions. Under normal conditions of management, full grown pigs consume approximately 8 litre water daily. Pregnant sow may drink more water, about 12 litre per day.

19.2.11 Exploration

Pigs show a very well developed exploratory drive, most of which is directed at objects at floor level which are investigated by smelling, nibbling and rooting. Such actions may have a destructive effect on objects, where these are subject to continuous investigation by a group of pigs, which are severely restricted in their movements. This is apparently the underlying cause of the vice of tail biting. The tendency to over-investigate specific items in their environment can be controlled to a degree by providing additional objects for investigation and some pig breeders, aware to this fact, provide growing pigs with objects to be used as toys. These includes motor tyre, and chains suspended from the ceiling. The provision of straw bedding also provides an alternative outlet for the investigatory activities of pigs.

19.3 Feeding and Ingestion Behavior

The snout of the pig is a highly developed sense organ and olfaction plays a large part in the determination of behavior. Rooting is the salient feature of ingestive behavior in pigs. When pigs are fed with finely ground foodstuffs, they continue to show rooting activities. Pigs at free range, eat a variety of vegetable materials. They may also eat some animals such as earthworms. Under modern system of husbandry, however, it is usual for pigs to be fed on compounded feedstuffs.

The quantity of food that pigs consume is marginally affected by the palatability of the feed stuff. They appear to prefer feedstuffs with some sugar content. Preference is also shown for other constituents such as fishmeal, yeast, wheat and soya bean. Substances which reduce the intake of food include salt, fat, meat-meal and cellulose. Generally, pigs appear to eat wet food stuffs more readily than dry ones, however, much is dependent on palatability. Pigs typically show hunger when feeding time approaches and it is evident that the temporal arrangement of their feeding activities is very well defined.

Community feeding stimulated by the sight of other pigs feeding. Pigs in groups are found to consume more food than pigs kept individually. Well grown pigs kept in pens in groups of 6 to 8 should, therefore, be given enough adjacent competitors being able to poach off them. It is estimated that pigs of 90 kg weight should have a minimum trough space of 35 cm each. The pigs are liable to competition in obtaining their full daily quota of food. The appetite is also depend upon the type of breed. Some breeds are greater hunger drives than others. Certain families of pigs have stronger feeding drives than others and that pigs from these families are usually faster growing. The selection of highly productive pigs, in many cases, involves very little more than selecting those genes which are basic to the feeding drive. Feeding drives are very important amongst breeding sows for regaining body weight which was lost during the preceding lactation. The main features of the ingestive drive are more specifically referred to as hunger and thrust. These behaviors are governed by hypothalamus. The lateral hypothalamus contains a feeding center which is subject to control automatically to maintain a stable of favorable balance of energy between ingesta and body.

A single pig will not eat as much as when it is one of a pair. A pair of pigs will in eat somewhat less than if they are part of a larger group. The piglets, which are observed to have good appetites and to be very active feeders when young, usually become good growers and adult producers.

19.4 Sexual Behavior in Pigs

19.4.1 Oestrous Behavior

The pig is a polyoestrous animal and puberty is achieved at the age of 5 to 9 months. The length of the oestrous cycle is 21 days and signs of oestrous lasts for 24 to 72 hours. The ovulation occurs at mid to later stage of oestrous.

A salient feature of estrous behaviors in the sow is the adoption of an immobile posture in response to pressure on the back. The pig attendant applies pressure on lumbar region of the sow or sitting on the back of the animal. The onset and termination are gradual and of low intensity but the standing period is sometimes restless, when enclosed. The static posture adopted by a sow in estrus in response to firm "haunch pressure".

The sow in estrous is restless when enclosed, this being rather more noticeable during the hours of night. Some breeds, those with erect ears, show a conspicuous pricking of the ears in full heat. The ears are laid close to the head, turned up and backwards and held stiffly. "Earpricking" is often shown when some movement is taking place behind the animal.

In pigs, the most complete analysis of the stimuli from the boar that lead to the copulatory stance by the gilt. The pressure on back only by man, 48% will respond by standing for mating; if pressure on back is accompanied by the broadcasting boar's courting grunts, 70% will respond; if odour of preputial secretion at 40°C is added, 80% will respond; smell and sound of boar will increase the % of response to 80%; while inclusion of sight of a boar will lead to response of 97% gilts.

Behavioral Signs in absence of Boar

The sows would show hyperactivity, i.e. sow mounting on another sow, genital sniffing and nuzzling.

When sows are not kept with boar, she takes initiative for search of a boar. She begin her search at least one day before the onset of oestrous.

19.4.2 Libido-the Sexual Response of Boar

Libido is the "psychic drive" or energy particularly associated with the sexual instinct. It is the willingness and

eagerness of a boar to mount and attempt service of female pig. Libido is very important ability of a boar to achieve intromission often enough to ensure the maximum chance of reproductive success.

To speed up genetic improvement, artificial insemination (AI) is practiced in which collection of semen is crucial. The male is required to produce an ejaculate without the presence of sow or gilt in oestrous. The libido of boar whose semen is needed for AI plays an important role in collection of semen.

19.4.3 Mating Behavior

The mating reaction time in pigs is one to ten minutes. The boar approaches sow giving series of grunt, noses vulva vigorously, champs jaw and froths at mouth. The short protrusions of spiral penis repeated till intromission occurs. The pelvic oscillations followed by somnolent phase. The duration of intromission takes about 9 minutes and semen is deposited intrauterine. The repeat matings are occurred, and many boars will serve a sow 3 to 7 times in heat period. The mating behavior of pigs is shown in Fig. 19.4.3.1.

19.5 Parturient behavior

19.5.1 Pre-parturient Behavior

In farrowing pens, within 24 h of parturition, most sows show restlessness, with the sow frequently altering her position, either from side to side when lying down or from lying to standing. This increases gradually until the sow changes position every few minutes. Intermittent grunting, champing of the jaws and increased respiratory rate.

The sows remains in lateral recumbency for farrowing. In the interval between births sows sometimes change to the ventral position and occasionally stand up. It is often heralded and accompanied by vigorous tail swishing.

19.5.2 Parturition Behavior

Births generally occur singly, through two or three or even more. The piglets may be born simultaneously. The average time taken to birth to the whole litter is about 3 h, but the time for the whole of farrowing is much longer. The birth is accomplished

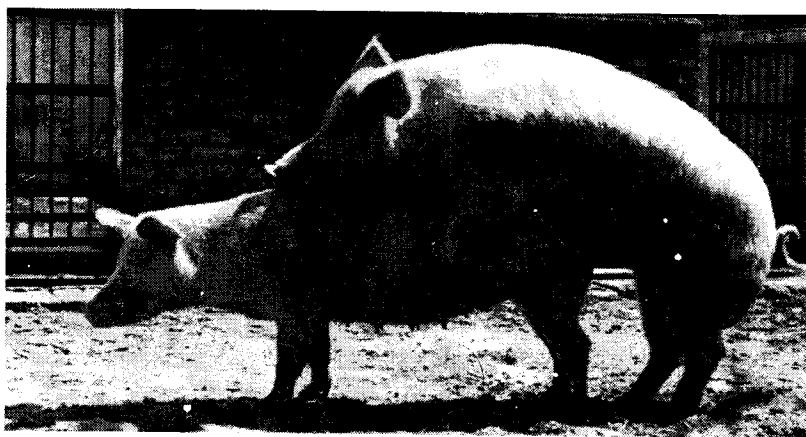
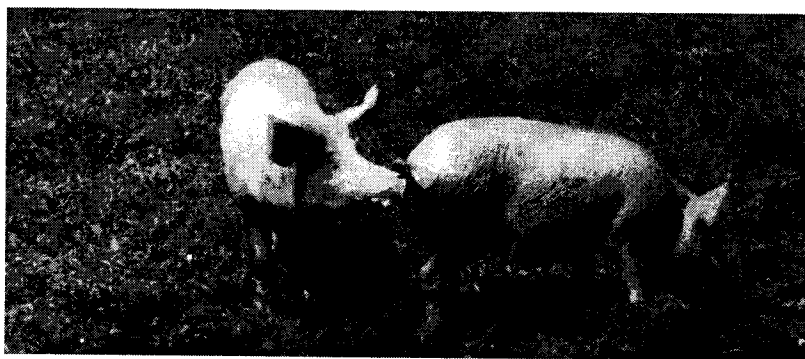
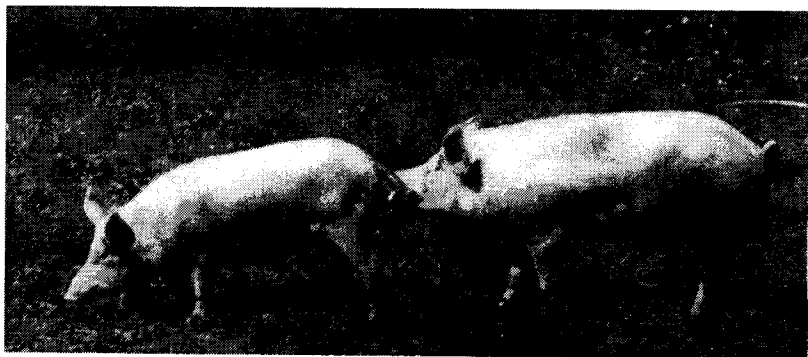


Fig. 19.4.3.1 Mating behavior of pigs.



Fig.19.5.2.1 Parturition in gilt.



Fig.19.5.3.1 Nursing behavior in pigs.

with ease and the newborn piglet is quickly on its feet and seeking the udder. The intervals between the birth of each piglets rarely exceeds 16 minutes. Gilts may show alarm when approached and even attack it. However, once the piglets are settled and suckled the subsequent litter piglets are more easily accepted. The parturition behavior of pigs is shown in Fig. 19.5.2.1.

A sow does not lick the newborn or sever the umbilical cord. She does lying down in such a way that teats are exposed.

19.5.3 Nursing and Maternal behavior

Early born piglets have no competitions for the teats and may suckle several. As more piglets are born, competition may arise between piglets and fighting is more intense 2-3 hours after birth. Later on the piglets will find their teats.

The sow receives the piglet for suckling either lying or occasionally standing. Each piglet then massages around its respective teat with rapid upward and downward movements of the snout. During suckling the sow grunts at slow, regular intervals. The massage lasts for about a minute and ends when milk flow begins. The piglets then appear to swallow at furious speed, rather than to suck. The milk flow appears to stop quite suddenly, the piglets then suck vigorously as if to draw the last drop and attempt to push one another away and if a spare teat is within reach, suck it alternately. The nursing sow is shown in Fig. 19.5.3.1.

During the period of milk flow the grunts of the sow are low in tone, through faster and often in quick runs of three or four, tapering from a high to a low note. She does grunting due to the stop of milk flow, frequently at this stage, one of the piglets, though not always the same one, will run around to its mother's nose and grunt excitedly.

The teat order is established extremely rapidly, often within one hour of birth. The piglets are rubbing their noses around the teat for marking of recognition and identification of teat order.

19.6 Fostering Behavior

Sows will accept "foster" piglets up to about 1 week after

farrowing. The sow's own litter should be removed, until she is waiting for them and they are hungry. Piglets to be fostered should be rubbed particularly in the perianal region with dung from piglets in the sows own litter. All the piglets should be put together and the sow observed to see that she accepts them all.

19.7 Abnormal Behavior in Pigs

Abnormal behavior in pigs is linked with stress, disease and management and social problems. The study of abnormal behavior, as reflected in health, disease incidence, reproductive fitness, growth, productivity, can be regarded as indicator of abnormality of health, management and husbandry. Then steps should be taken to improve the system.

19.7.1 Can Pig feel and express?

Pigs can experience the same basic emotions of pain, pleasure, distress, fear, anxiety, and anger as human do. Some of their expressions- vocal and visual are identical to those in man.

It is no zoomorphism to say that pigs and people make similar grunts of contentment; an angry person bellows like a pig and vice versa.

19.7.2 Stress in Pigs

Stress is an unavoidable reaction to any condition, stimulus or experience disturbing homeostasis. It can be reduced through proper design of husbandry systems to allow pigs the opportunity to mobilize adaptive behaviors.

The pigs in a study showed that when hungry pigs are submitted to the frustration of intermittent food delivery they exhibited the stress associated with high rate of cortisol production. The stress in pigs is shown in Fig. 19.7.2.1. The negative nursing response is shown in Fig. 19.7.2.2.

19.7.3 Abnormal Behavior of Pigs

Cannibalism

cannibalism refers to biting of tail, ear and vagina and biting of joints. Tail biting begins with a pig taking another's tail cross wise in its mouth and chewing on it. This does not result in a wound. The animal whose tail is being bitten tolerates the biting,



Fig. 19.7.2.1 Stress in Pigs.

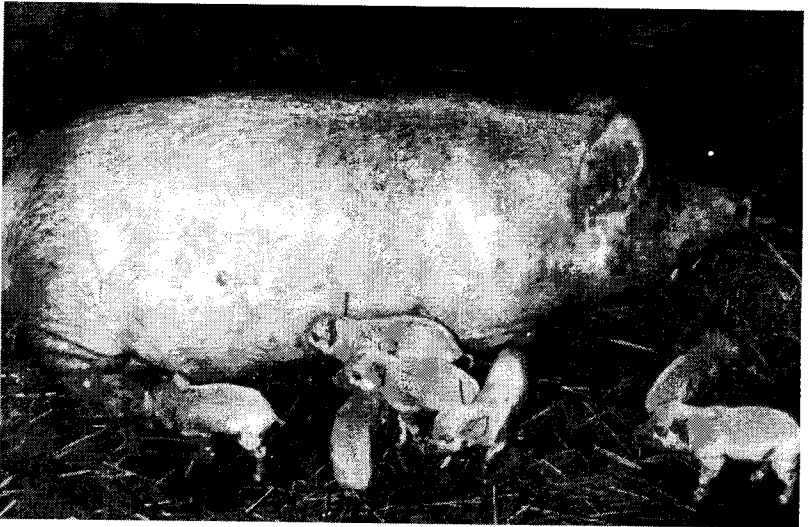


Fig. 19.7.2.2 Negative nursing behavior.

showing no painful reaction. Gradually the active animal bites harder, causing a wound and blood extravasation. This in turn encourages the active animal in further biting efforts. Other animals also take part in the biting and the wounded animal becomes the object of a hunt. Piece by piece, the tail is eaten away until the root of the tail is removed. The pigs then begin biting the ears as well as the vagina and joints, which is accompanied by excessive unrest and agitation on the part of all active pig biters.

The wounded animal gradually gives up its resistance and its efforts to flee. The affected animal show retarded growth, weakness, loss of blood and lack of appetite. The constantly moist tail lead to inflammation and formation of abscesses in the spinal canal, lungs, kidneys and other organs and inflammation of the joints.

The possible cause of tail biting includes dietary deficiency of roughage, iodine, iron, calcium, salt and lysine; boredom, restlessness, poor ventilation, mange mites, endocrine disturbances, low barometric pressure, lack of feeder or drinker space, overcrowding, wet floors and reduction of straw or flooring, increased level of noxious gases i.e. carbon-di-oxide, ammonia and hydrogen sulphide; high humidity and temperature.

Control

1. The active biter and bitten animal should be segregated from the group.
2. Put twig, straw, hay, wood shavings, earth to satisfy the animals drive.
3. The wounded animals should be applied tincture of iodine.
4. Add fish meal, amino acid supplement and protein supplement to overcome deficiency of nutrients.

Anal massage and ingestion of feces

During period of activity or general unrest among pigs in dense groups, the active animals may move from one pen members to the next, trying to massage the anus with snout. If feces are excreted as a result of massage, this material is eaten

by the active animal. The massage can lead to wounds in the area of the anus. The female animals engage more intensively in anal massage than do castrated males.

To control this activity, limit the stocking rate in the pen, reduce the possibility of contact between pigs in different pens by screening. Place chewable objects like hay, twigs etc. to channel the pursuit of mouth activity.

Bar-biting

Bar-biting is observed in breeding sows which are kept in single crates. These animals are kept on perforated litter-free floors or on concrete floors, which are litter free. The sow takes a bar in its mouth and bites on it. This may be due to poor husbandry and boredom. The visible injury and this behavioral disorder can be reduced by improving the husbandry practices. Positive results can be attained by supplying straw or saw dust or by feeding grass cobs.

Eating as a Vacuum Activity

This activity is observed in single kept sows without litter. The animal chews without having anything in its mouth. This is characterized by widening of mouth gap and foaming on the lips.

This activity occurs when the sow is lying down or in dog-sitting posture. It can go on hours over several days. This can be prevented by providing straw and saw dust litter to dig and bite. The feed should be supplemented with roughage and mineral mixture.

Excessive aggression

This behavior is due to the social isolation, food competition, overcrowding, inability to submit forced encounters.

Pica

This is due to dietary deficiency, boredom, excessive restraint or confinement, impatience with delayed feeding.

Excessive eating

This activity is observed due to boredom.

Infertility or low fecundity

Infertility is also observed due to social isolation or confinement.

Excessive huddling

This is due to cold stress.

Fouling lying area

This is due to hot building, poorly ventilated or poorly designed building.

Loss of appetite

The loss of appetite is associated with heat stress.

Starvation of piglets

The starvation of piglets may occur due to improper trough design.

19.8 Empathy

There are number of reasons why pigs should be treated humanely. A stockman who knows his pigs, who can “*think like a pig*”, usually does a better job than one who lacks this basic and essential knowledge.

Studies have shown that the reproductive performance of sows is enhanced when the animals are treated with “*tender loving care*”.

19.9 Behavior of Wild Pigs

Wild pig seen by day are extremely fugitive and bolted at the sight or scent of man. Pig running away do not turn round for visual confirmation of a scent warning or to see if they are being followed. They change direction suddenly in flight and take advantage of every dip and bit of cover to disappear from view. The male is aggressive and even attacks human-beings.

These pigs are crop-raiders, and do substantial damage to groundnut, digging up an entire field overnight. The pigs are fond of wallowing, but differ from other animals like to wallow. They like some shallow water over the mire, and not merely deep mud. They used to drink water at midday, in the afternoon and late in the evening. They also used to hunt frogs and insects in the soggy grass. They do eat a variety of animal prey, but the bulk of their food is vegetarian and much of it the underground



Fig. 19.9.2.1 Speed of Wild Pigs.



Fig. 19.9.3.1 Social Behavior of Wild Pigs.

stolons, rhizomes, corms and bulbs of plants. The wild pig can dig up the ground with their snout. A groundnut field visited overnight by pig, looks as if it had been freshly ploughed up. They eat tender tall grass and root for the stolons and rhizomes of sedges and grasses.

19.9.1 Locomotion

Many species, if they find enough food, they remain in that locality which comprise of feeding areas, water holes, and wallows. They may also roam over great distances in search of food. The usual form of locomotion is trot over short distances and long distances can be covered by fast galloping. They are excellent swimmers and can even cross rivers and channels of several kilometers.

19.9.2 Speed

In spite of their mass and extraordinarily thick in body build, pigs are agile and capable of considerable speed. The big boar can leap easily over a bush, up to 3 foot high. Pig walk on the third and fourth digits of each foot, while the smaller second and fifth digits are usually clear of the ground. The speed of wild pigs can be judged from the Fig. 19.9.2.1.

19.9.3 Social Behavior

All wild pigs are gregarious animals, living together in pairs or in group. The focus of the group is usually a female with young piglets. Older boars often live alone except during mating season. At preferred feeding places or on migration, the groups may form herds of considerable size. The social behavior of wild pigs are shown in Fig. 19.9.3.1. A resting wild boar can be seen in Fig. 19.9.3.2.

19.9.4 Sense Organs

The senses of smell and hearing are well developed. Pigs are highly vocal and family group communicate incessantly by squeaks, chirrups and grunts. A loud grunt may herald alarm, while rhythmic grunts characterize the courtship chant. Smell is the prime sense and sight and hearing are only fair. Sow build regular nests of tall grass for their accouchement.

Pigs are well able to make out moving objects from a

distance. When suddenly warned of danger by smell or otherwise, the erectile ridge of hair from the forehead to the hindquarters bristles and stands up suddenly.

19.9.5 Communication

Pigs can communicate by squeaking and grunting sounds. One can distinguish various calls for maintaining contact, calling young piglets and others, alarm, attack, mating and distress. They can also produce different snorting and sneezing sounds. They can also produce sound with their teeth. They have a poor vision and can see at short distances only. The sense of smell is well developed.

19.9.6 Protection and Fighting

Boars use their canine teeth as defensive weapons against predators. In minor conflicts, pigs bite the opponent or push him away with their snout. Serious fights occur mainly between adult boars during the rutting season. The boars use their sharp canine teeth for tearing and slashing. They attack each other either frontal or from the side. Fighting behavior of wild pigs is shown in Fig. 19.9.6.1 and 19.9.6.2.

19.9.7 Wallowing

Pigs are very fond of wallowing in which they like some shallow water over the mire, and not merely mire for this purpose. A very big boar lying in 3-inch deep water in a puddle on a forest road, soon after heavy rain, rolling over and squirming about so violently like that, the animal had been seized with a fit. The pigs wallowing in shallow, dirty water rub their sides and hindquarters well into the mire to get them scrubbed with squirming and rolling movements. A wild boar going for wallowing is shown in Fig. 19.9.7.1.

19.9.8 Feeding Behavior

Pig's diet is extremely varied, as they eat tubers, bulbs, grass, leaves, sprouts, fallen fruit, seeds, juicy herbs and mushrooms. Food below the surface is dug out with the snout. They are able to find food quickly even deep in ground due to their extraordinary sense of smell. They also eat worms, the larvae of insects, eggs and young birds, snakes, lizards and small



Fig. 19.9.3.1 Wild pig at rest.



Fig. 19.9.7.1 Wild boar going for wallowing.

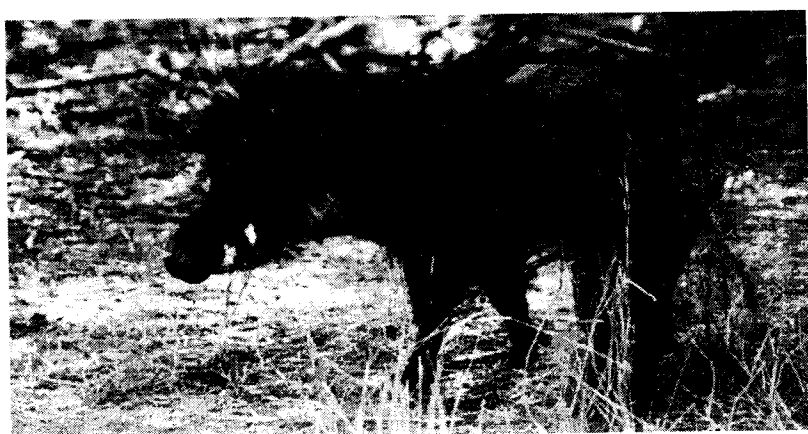


Fig. 19.9.8 Wild boar in search of food.

rodents. A wild boar in search of food can be seen in Fig. 19.9.8.1.

19.9.9 Reproductive Behavior

It is highly prolific and breeds in all seasons. Sexual maturity is attained at about 18 months, although males may only gain access to sows on reaching physical maturity at about 4 years old. Pigs may breed throughout the year in the moist tropics but in temperate and tropical areas of marked seasonality.

In intensive practice in zoos, data indicate that a pattern similar to that in domestic pigs in which boars runs continuously with the sow herd. In extensive conditions, sow may begin to increase spontaneous activity and become more reactive and nervous three or four days before oestrous. During oestrous, activity may increased twice its normal level. Some sexual interaction between sows is common; sniffing and licking of vulva, pushing and nuzzling the flanks and between the hind legs and mounting. Sows also gravitate towards and stay close to the boar during pro-oestrous and may sniff and nuzzle him in the anal and preputial regions.

Mating

The courtship involves champing of the mouth, production of submaxillary saliva secretion, a vocal "*chant de coeur*", release of boar odour from preputial gland, which contains androstenol, nosing of the flank and vulva of the sow. The duration of copulation takes place from 3 minutes to 20 minutes. Under natural conditions a boar and a sow may copulate 7 to 11 times over a 70 hour oestrous period.

The boar may court the sow intermittently and with continuous contact for more than 24 hrs. The boar may show signs of running after her, nosing the side, flanks and vulva, sniffing or licking the vulval region, nudging and pushing with the head and snout at the sow's head or flank or between her hind legs. A characteristic guttural grunt, with grinding of teeth and foaming at the mouth and rhythmic urination may be visible. If the sow rapidly and repeatedly escapes, he may soon give up, but if courtship is effective, she may stand alongside him head-

to-head or head-to-tail and bite ears lightly, nuzzle his flank, scrotum or preputial area, and even attempt to mount him. Mock fights may occur, especially if she resists mounting.

If she stands rigidly with arched back, the boar then mounts and few pelvic thrusts, forelegs clasp the sow's flanks, are usually sufficient to achieve intromission. A long slow ejaculation lasting for 4-5 minutes follows, characterized by a wavelike motion of the perineal muscles, reflected in anal winking. The sow remains motionless throughout, but may move slightly without upsetting ejaculation. She is unresponsive to other events and difficult to herd. She may flex the muscles attached to the ear and move the pinna sideways during mating. After copulation, she may lick the froth about the boar's penis.

When sow is kept along with the oestrous sow, the boar may mate up to 12 times during oestrous, with anything between few minutes to many hours between each mating.

Mating Season

The mating occurs in the fall the sow farrow the following spring. In moderate climates, the pigs have rutting season, while in tropical climate, pigs may mate all year round. In tropics reproduction is determined by the rainy season. Prior to copulation, a special ritual occurs where the boar causes the female to stand still by making special sounds and by massaging her with his disc-like snout. They have one litter per year, but in favorable conditions, they may have two also.

Nesting

Sow build regular nests of tall grass for their accouchement. The old nests are abandoned after one farrowing and are visible in the neighborhood of regular nests. Females usually separate from the group before giving birth. They seek a sheltered, dry place and dig a cave or a depression which they may line with various plant materials. They even build a roof over their nests.

Pre-parturient sow include intermittent grunting, champing of the jaws and rapid breathing. There is also a significant enlargement of the mammary glands. During the 24 hour period before parturition nest-building also takes place. This activity



Fig. 19.9.6.1 Fighting behavior of wild boars.



Fig. 19.9.6.2 Fighting behavior of wild boars.

may start up to three days before parturition. The sow will attempt to clean and dry her selected birth site and will chew long grass or straw to provide bedding, carrying it a considerable distance if necessary. The location of the prospective birth site may be changed more than once. Pawing activities are evident where the sow uses her forelegs to move the bedding material about. The sow adopt and maintain a lying posture at rest before birth. It has been observed that free-living sows like to find a wooded areas to build a den with dry vegetation. The dens are lined.

Farrowing

The piglets are born in rapid succession. The piglets are small and 'rounded' in shape. After reaching the ground, they immediately starts crawling. The movement results in the severing of the umbilical cord and may tear anywhere along its length. Sows do not clean placenta or clean or lick the piglets.

Piglets are born into a prepared nest. The birth is accomplished with ease and the newborn piglet is quickly on its feet and seeking the udder. The intervals between the birth of each piglets rarely exceeds 16 minutes. Immediately after the birth, the young piglets begin searching for the nipples of the lying mother, massaging her udder with their snouts. While suckling, the little piglets quarrel frequently at first because each tries to obtain the nipple with the most milk for itself. However, after some time they establish a stable hierarchy in which each piglet has his own specific nipple. Young piglets have only a few hairs and require an extraordinary amount of warmth. During their first few days, they do not leave the nest but lie together near the mother, who usually stays with them. Female sow with young piglets is more alert and aggressive than many other ungulates. Piglets are nursed for two to three months, but they soon start to take other food in addition to the mother's milk.

The young one are born in a grass nest constructed by the sow and weigh between 500 to 900 g. The piglets remain in the nest for about 10 days before following their mother. Each piglet has its own teat. Weaning occurs at about three months of age.

but young piglets remain with their mother in a closely knit family group until she is ready to farrow again. The puberty in wild gilts varies from nine months to twelve months of age. They may live 15 to 25 years.

Maternal Behavior

In wild pigs, cross-suckling can occur in litters born at about the same time. However, no rejection of her own piglets. Smell has a role in offspring recognition after bonding as normal sow did show some aggressiveness to aliens.

19.10 Behavior of Pigmy Hog

The herd consists of 5-6 to 15-20. The males fearlessly attack intruders, charging and cutting the naked legs of their human or other attackers with a speed that baffles the eyesight, and a sprit which their straight sharp laniaries renders really perplexing. The elephants, often enough, are scared to death by the pigmy hogs, for the little creatures have tusks as sharp as razors, and gash the elephants' feet with them as they rush past them. Hamilton (1921), describing a shooting expedition with the Maharajah of Cooch Bihar in 1891, states that they go about in droves of about fifty, and move through the grass with such incredible rapidity that the eye is unable to follow them.

The pigmy hog is nocturnal, however they are most active just after dawn and some two hours before sunset. They chiefly found in tall grass jungles and is said to live in group of 5 to 20 individuals. It's food comprises of roots, bulbs, insects and birds' eggs. Adult male joins the oestrous female from late December to early February. Birth has been recorded during April- May and September. In captivity, the litter size varies from 2 to 6.

Nesting

Just prior to giving birth the females are said to make a nest within the thatch. The litter consists of usually 3-4 piglets, and produce two litters a year. The gestation period of sows is 110-120 days. The mammae comprise of 3 pairs. The longevity of pigmy hog is 10-12 years.

Food Habits

The main diet of pigmy hog is roots and bulbs but also eat eggs, young birds, insects and reptiles.

20. TRANSPORT OF PIGS

When pigs have to be transported long distances over poor roads, losses from death can be increased due to stress. Overloading may cause losses of 2 to 5% of pigs during transportation. Proper handling and management would reduce the risk of loss of pigs during transportation.

20.1 Need for Transport of Pigs

There has been more emphasis on the importance of pig transport in recent years.

The transport of pigs from pig breeding farm to fattening farm and from farm to abattoir is a fundamental part of the process of pork production.

20.2 Points to be considered before transport

1. Pigs should not be fed at least 6-8 hours before despatch to avoid vomiting and diarrhea.
2. Pigs should be transported during the coolly part of the day.
3. The speed of vehicle should not be very high.
4. Space allowance of 0.4-0.5m² per slaughter pig are recommended by the Meat and Livestock Commission in U.K.

20.3 Transport of Pigs by Road

If the duration of journey is less than 12 hours, all ages of pigs can be comfortably transported by road. The minimum floor space required for weaner, young pig, adult and sow with litter for road travel shall be 0.30, 0.45, 0.60 and 1.2 m² respectively as per Indian Standard Code for Transport of Pigs (IS:5236-1982).

General Conditions for Transport of Pigs

1. The healthy pigs in good condition shall be transported.
2. Sows in advanced stage of pregnancy should not be transported.
3. Special arrangements by providing suitable partitions should be made to protect the boars from infighting.
4. Arrangements may also be made to protect the young piglets from crushing when sows with litter are transported.
5. An attendant along with first aid equipment should accompany the pigs in transit.



Fig. 20.3.1 A transport Vehicle for pigs.



Fig. 20.3.2 Loading of pigs for road transport.

6. There is no need to carry feed for journeys less than 12 hours. However, sufficient feed shall be carried for journeys over 12 hours.
7. Watering should be provided at regular intervals.
8. Light and heavy pigs should not be mixed during transportation.
9. Boars should not transported with sows or gilt to avoid mounting on females in heat.
10. All vehicles should be inspected for safety, suitability and cleanliness before loading the pigs. The floor and walls should not have damaged surfaces or sharp projects like nails, which may cause injury to pigs.
11. The transporting vehicles should be thoroughly sprayed with suitable disinfectant before loading the pigs.
12. A layer of clean sand of more than 6 cm thickness should be provided. This layer of sand shall be moistened with water during the summer month.
13. Arrangements should also be made to sprinkle water on pigs at frequent intervals.
14. In winter months, a 2 cm thick layer of clean sand with 6 cm layer of whole straw shall be provided.
15. In extremely colder and hotter months, the truck should be covered to avoid respiratory disease and heat stress.

Details of the Consignment

Each consignment should bear a label showing number and kind of pigs loaded, name, address and telephone number of the consignor; name, address and telephone number of the consignee; quantity of feed provided; and instructions regarding feeding and watering of pigs.

Loading of Pigs

The loading of pigs should be preferably be done at morning or evening to avoid extremes of temperatures. Suitable ramp should be provided for loading and unloading the pigs. The ramp should be at least 1.5 m in width with raised sides at least 0.75 m high. The floor of the ramp shall have cleats at intervals of 0.15 m. so that pigs do not slip as they climb or descend. The

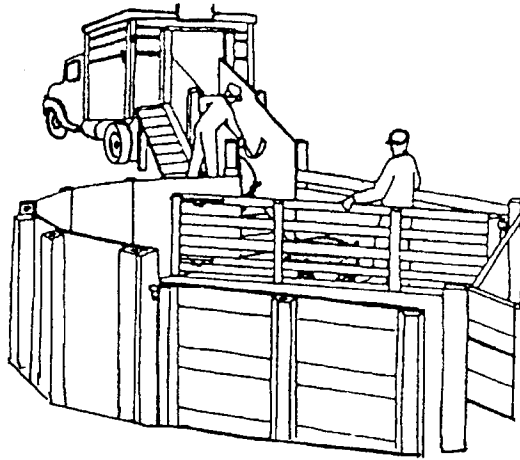


Fig. 20.3.3 A device for easy loading of pigs.

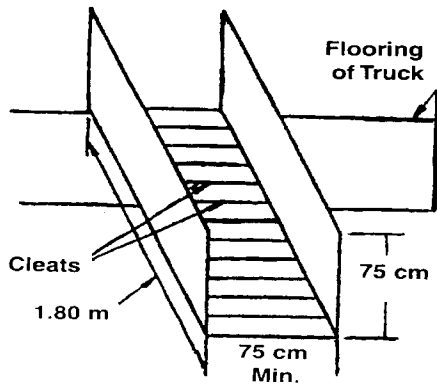


Fig. 20.3.4 A typical ramp for loading of pigs.

angle of the ramp with the floor shall not be more than 30°. The ramp shall be covered with straw to avoid slipping. The loading of pigs for road transport is shown in Fig. 20.3.2. A device for easy loading of pigs can be seen in Fig. 20.3.3. A typical ramp for loading of pigs into truck is shown in Fig. 20.3.4.

Moving Pigs from Farm to Bacon Factory

The pigs are dispatched very early in the morning. Once the vehicle has left the farm, the haulier is responsible for the care of the pigs. Many hauliers use multipurpose vehicles, and a vehicle which is designed for cattle or sheep haulage may not be ideal for pig transport. Ventilation and types of flooring are better designed for individual species. A specially designed, naturally ventilated truck can carry 180 slaughter-weight pigs.

Problems of Pigs during transport

Vomiting during transport is fairly common and is thought to be caused by pigs being fed shortly before loading. Pigs may die from choking and suffocation through inhalation of their own vomit.

Blemishes or marks on the skin and bruising may occur, if pigs are over crowded. The stocking rates in transit may affect the degree of bruising as tightly-packed pigs struggle to find sufficient room. Too much space may also lead to injury due to the motion of the vehicle.

High temperatures, excessive exercise, the emotional stress of mixing with unfamiliar animals and food and water deprivation are likely to produce stress during transport. The stress is responsible for low meat quality, as the incidences of PSE (pale, soft and exudative) and DFD (dark, firm and dry) meat.

Transport Vehicle Design

Two-decked, naturally ventilated vehicles with loading facility is useful for transport of pigs. The internal pen divisions are constructed in such a way to allow air to flow through them. The slots along the sides should be as large as possible.

Triple-deck vehicles can also be constructed, which would allow more floor area per pig. However, air space is reduced, so

good ventilation is essential. These are more suitable for weaner transport, as the headroom allowed for each deck is restricted and access during transport is difficult. A specially designed vehicle used for road transport in U.S.A. is shown in Fig. 20.3.1.

Driving Technique

In India, no ideal vehicle for transporting pigs has been designed. However, conditions can be improved during transit by adopting proper driving technique.

The speed of truck transporting pigs should not be exceed 40 kms/hour to avoid jerks and jolts. The truck should not stop frequently to reduce stress.

20.4 Rail Transport of Pigs

For journeys, exceeding 12 hours, pigs should preferably be transported by rail.

General conditions for transport of pigs by road can be adopted for transport of pigs by rail.

Loading

The door of the railway wagon may be used as ramp. The bags of hay, bhusa etc. may be placed on the either sides of the dropped door to prevent the pigs from getting their legs between the sides of the wagons and platform.

Maximum number of Pigs in a Railway Wagon

If the area of the railway wagon is less than 21.1 m², 70 weaner, 50 young pigs, 35 adult pigs and 18 sows with litter can be transported. However, if the area of wagon is more than 21.1 m² and above, depending on the size of the wagon, up to 100 weaner, 60 young pigs, 50 adults and 20 sows with litter can be comfortably transported.

20.5 Air Transport of Pigs

The import of breeding pigs is only possible through air. It requires intense planning and preparation to minimize loss during transport.

Planning

Planning begins at the time of the selection of pigs, which may be done many weeks in advance. Normally 30 days quarantine is essential in the country of selection. The weight



Fig. 20.5.1 Air Transport of pigs.

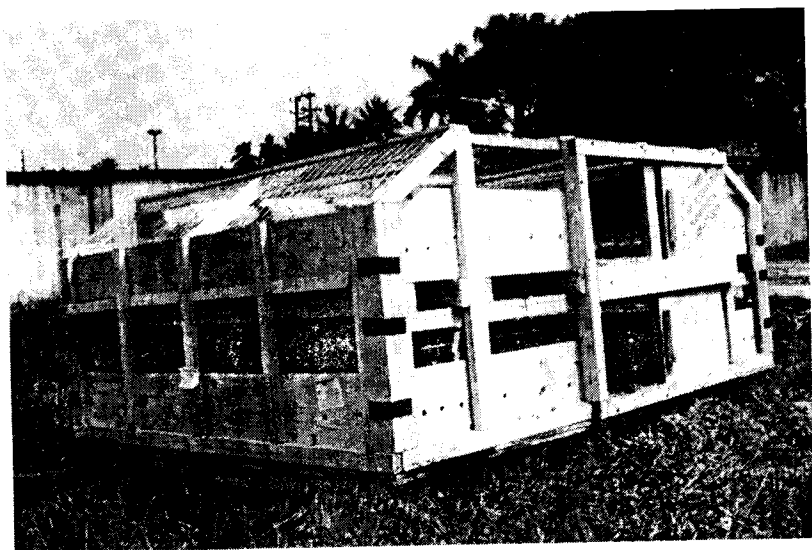


Fig. 20.5.2 A crate for air transport of pigs.

of the selected pigs should be taken many days before the intended date of despatch. Suitable airline crating would be ordered and pigs would go in isolation quarter to be ready for the veterinary tests. Transport of pigs by air and crate for transporting pigs is shown in Fig.20.5.1 and 20.5.2.

The blood testing of the selected pigs might start 28 days before dispatch and carry on through to 14 days. The final inspection, and loading would be on the day before the flight. Provision should be made based on their live weight at selection for growth projections for calculating the floor-space and head-height allowances at the time of day of export. Pigs awaiting export gain body weight of 400 to 600 grams per day.

Collection from the quarantine center and delivery into the aircraft may take longer than the projected airflight. Careful attention should be paid to the order of loading, group sizes and method of crating. Pigs should be easily identified and preferable be grouped at quarantine station according to their penned groups in flight to avoid reducing the amount of mixing and stress.

All the paperwork and documentation including health certificate, pedigree certificate, registration certificate, ear numbers should be completed well in advance and 4-5 copies of these documentation should be prepared to avoid delay. All the tags of the pigs should be checked to avoid error. The tags should be of legible plastic tags and should tally correctly with the tattoo numbers to avoid any confusion.

About 4-6 hours are allowed for clearing documents through customs and transferring the pigs from vehicles into crates.

Pigs should be given some water immediately before flight to avoid dehydrating during aircraft. The container should be marked with instructions of feed and water and time of last drink to take proper care in the event of delays in transit.

A floor area of 0.15m² is recommended for a pig weighting 25 kg. However, stocking rates are affected by the type of aircraft, type of penning and length of journey. Crates should be designed in such a way to facilitate proper ventilation and temperature.

Low temperature in the range of 10 to 25°C is recommended during flight.

Pigs also dislike the increase in pressure on their ears in the last 20 minutes or at the time of aircraft's descent.

21. PIG QUARANTINE

Animal Quarantine is the isolation of certain animals that may carry danger of infection. The period of quarantine depends on the amount of time needed to protect against a certain disease. It is an international law, name given to the regulations of a country imposing a period of time during which a ship or aircraft arriving in port is forbidden to land because it is suspected of being infected with a contagious disease.

21.1 Comments of NCA on Animal Quarantine

National Commission on Agriculture (1976) pointed out that

“35.7.1 An efficient animal quarantine organization is essential to safeguard the health of livestock against the exotic diseases. However, in India this very important requirement of animal health has not so far received due consideration and an effective quarantine service is lacking. As a result certain exotic diseases like swine fever disease entered the country in recent years and caused heavy mortality in pigs.”

“35.7.2 Swine fever struck during the early part of 1962 and caused heavy mortality in the pig population.”

“35.7.7 At present quarantine stations do not exist on borders with Bangladesh, Burma, Bhutan and Nepal. As trade in livestock and livestock products is bound to increase, we recommend that quarantine stations on Indian borders adjoining these countries should be established.”

NCA also recommended that

“51. As swine fever is almost wholly under control, quarantine regulations should be rigidly followed in the case of all pigs imported from abroad.”

21.2 Need for Animal Quarantine Service

In India, we have recognized good breeds of cattle, buffaloes, sheep and goats but there is no good indigenous breed of pig which can be used in commercial pig production. The exotic breeds of Large White Yorkshire, Landrace, Hampshire, Berkshire etc. are being maintained at 158 State Government Pig Breeding Farms. Due to inbreeding there is a regular need of import of pigs for supply of improved piglets to farmers.

21.3 Pig Health in India

India is fortunately free of all the major pig diseases like transmissible gastroenteritis and Aujeszky's disease of pigs. At present pork products are also being exported to various

countries. If major pig diseases are under control, India can increase its export of pork products.

21.4 Export and Import Policy

The Export and Import Policy (1998-2002), the law pertaining to livestock requires that a livestock should be accompanied by valid health certificates.

A license is required for import of pigs, which is being issued by Directorate General of Trade (DGFT), Ministry of Commerce, on the recommendation of Ministry of Agriculture, Department of Animal Husbandry and Dairying. A license to import will not be issued unless all health requirements of India have been met.

21.5 Animal Quarantine and Certification Service

Animal Quarantine and Certification Service (AQRS) Head Quarter at New Delhi with four Animal Quarantine and Certification Centers functioning under control of Ministry of Agriculture, Department of Animal Husbandry and Dairying, which is located at New Delhi, Mumbai, Calcutta and Chennai.

Certification is issued by AQRS authorized Animal Quarantine Officer based on inspections, examination of various official animal health records and declarations provided by owners and private veterinarians.

The law requires that all imported animals should be detained in quarantine for a minimum period of 30 days. In the event of an outbreak of a disease in transit the consignment should be impounded and detained in quarantine for a period of 90 days.

21.6 International Classification of Diseases

The Office International Epizootics (O.I.E.) has classified livestock diseases into three lists according to the severity and case of transmission. The broad spectrum of diseases included in list A are considered most dangerous and those included in list B and C are less severe in that order.

21.7 General Agreement on Tariffs and Trade (GATT)

General Agreement on Tariffs and Trade (GATT), which came to completion in April 1994, resulted in a set of

comprehensive trade agreements, including an “Agreement on the Application of Sanitary and Phytosanitary Measures (SPS)”.

21.8 Sanitary and Phytosanitary Measures

The sanitary measures includes laws, decrees, regulations, requirements, and procedures which are applied to protect human or animal health and life against risk arising from

- a. The entry, establishment of spread of pests, diseases, disease carrying organisms or disease-causing organism and
- b. Risks arising from disease-causing organisms in feedstuffs.

21.9 International Animal Health Standards

The OIE is the international organization responsible for the development, elaboration and promotion of international health standards, guidelines and recommendations affecting trade in live animals and animal products.

22. PIG NUTRITION

22.1 Role of Nutrients in the Diet

Nutrients plays an important role in the diet of pigs, as different nutrient in variation in quantity are required at various stages of life cycle of pigs.

Energy

Energy is the largest and important component of swine diets. Energy is yielded by the carbohydrates, fats and proteins. Most of the energy needed by the pig is supplied by dietary carbohydrates, but the pig do not have specific enzymes for digesting plant cellulose based carbohydrates. Fat is very rich in energy. Protein is the least efficiently used of all sources of energy and needed in the synthesis of new body protein. The digestibility of fats and oils is 20 to 90 %, carbohydrate in the form of starch is 95 % and the plant cellulose compounds is very low. The digestibility of cereal grains can be improved by reduction in the particle size by fine grinding and cooking.

The energy is required for maintenance, production and growth. The requirement of energy increases in pregnancy, lactation and growth. During growth, the energy required for maintenance increases with the size of the animals. In initial stages of growth the energy is converted into the protein but in later stage most of the energy is utilized for conversion of body fat. The body temperature of pigs must be maintained in the region of 39°C to avoid large quantity of wastage of energy for the control of body temperature.

Protein

The protein is needed for growth, maintenance and production. Inadequate dietary protein causes the slow growth and inefficient feed utilization. The protein requirements for gestation and lactation are more than production. The protein is also needed for fertility and long term reproduction. The reproductive performance in terms of number, weight and composition of piglets born per litter is maximized when the sow is given a daily allowance of 140-180 g crude protein subject to needs for amino-acids.

Minerals, Vitamins and water

Though minerals and vitamins are needed in small amounts in the diet, but it has shown to produce a maximum response of characteristics of economic importance.

Vitamins are substances present in natural feed stuff, essential for health. The vitamins are added into pig diets in the form of vitamin supplement.

22.2 Nutrient Requirement of Pigs

The nutrient requirements for different stage of life cycle are given in following tables:-

22.2.1 Energy Requirements

Age of Pig	Live-weight (kg)	FU/day
Piglets 3 weeks 5 weeks 8 weeks		0.5
		0.7
		1.0
Growing-finishing (rapidly growing pigs) For slower growing pigs remove 0.2 FU/day for ad libitum fed animals (1)	20	1.2
	30	1.6
	40	1.9
	50	2.2
	60	2.5
	70	2.8
	80	3.0
	90	3.2
	100	3.4
Gestation (2)	150	2.2
	250	2.5
Lactation (8 piglets) maximum amount(2)	150	6.5
	200	6.8
	250	7.2
Boar	150	2.5
	250	3.1

(1) American standards have been employed using diets of high nutrient concentration (1.09 FU/kg) fed *ad libitum*. Meeting these requirements completely would always result in excessively fat carcasses.

(2) Standards proposed by Salmon-Legagneur (CNRZ). For lactating sows, maximum requirements have been indicated: they must be reduced by around 50% to give the diet for the beginning and the end of lactation.

(National Research Council, 1965).

22.2.2 Crude protein requirements

Stage of life cycle	Expected mean daily liveweight gain (g)	Live-weight (kg)	Daily crude protein requirements (g)	% Crude protein in the diet
Pigs	272	5-10	118	22
	454	10-20	204	18
	590	20-35	268	16
	726	35-60	376	16
Growing and fattening	771	60-80	427	14
	863	80-100	494	14
Gestation (2)	-	150	312	12
	-	250	375	12
Lactation (at maximum production) (3)	-	150	-	16
	-	250	-	16
Boar	-	150	409	15
	-	250	445	13

- (1) Crude protein digestibility varies from 80% to 75% based on body wt. 15 kg & beyond.
- (2) Standards proposed by Salmon-Leganeur (CNRZ)
- (3) Daily crude protein requirements of lactating sows have not been presented: these amounts are dependent upon the dry matter intakes of sows (160 g crude protein per kg dry matter). (NRC,1965).

22.2.3 Essential amino acid requirements

Amino acid(% of diet)	NRC Standards Young pigs 10-40 kg	French Standards (Rerat)	
		10-60 kg	60-100 kg
Arginine	0.20	-	-
Histidine	0.20	0.26	0.19
Isoleucine	0.55	0.67	0.53
Leucine	0.60	0.86	0.65
Lysine	0.75	0.84	0.62
Methionine (1)-Cystine	0.55	0.62	0.47
Phenylalanine (2)	0.50	0.48	0.35
Threonine	0.45	0.58	0.42
Tryptophan	0.13	0.19	0.14
Valine	0.50	0.57	0.42

- (1) Cystine may replace 50% of the requirements for methionine. Methionine should be used in the DL form.
- (2) Tyrosine may replace 30% of the requirements for phenylalanine.

Note: NRC standards are based upon diets of a higher nutrient concentration than those usually found in France (1.09 FU/kg) which are fed *ad libitum* in contrast to the restricted pattern in France.

22.2.4 Mineral Requirements.

Stage of lifecycle	Live weight	Daily requirements (g)			% of diet		
		Ca	P	NaCl	Ca	P	NaCl
Growing/ finishing pigs	5-10	4.4	3.3	2.7	0.80	0.60	0.50
	10-20	7.4	5.7	5.7	0.65	0.50	0.50
	20-35	10.9	8.4	8.4	0.65	0.50	0.50
	35-60	11.8	9.4	11.8	0.50	0.40	0.50
	60-80	15.2	12.2	15.2	0.50	0.40	0.50
	80-100	17.7	14.2	17.7	0.50	0.40	0.50
Gestation	150	15.0	10.0	12.5	0.60	0.40	0.50
	250	17.7	11.8	14.7	0.60	0.40	0.50
Lactation	150	29.9	20.0	25.0	0.60	0.40	0.50
	250	34.0	22.7	28.4	0.60	0.40	0.50
Boar	150	16.3	10.9	13.6	0.60	0.40	0.50
	250	20.4	13.6	17.0	0.60	0.40	0.50

22.2.5 Trace element requirements.

Trace element	Requirements mg/kg diet	Tolerance mg/kg diet	Toxicity mg/kg diet
Copper	10.00	100	250
Iron	80.00	1000	4000
Iodine	0.20	-	-
Magnesium	400.00	-	-
Manganese	40.00	80	500
Zinc	50.00	1000	2000
Selenium	0.10	-	5

22.2.6 Vitamin requirements

Stage of lifecycle	Live weight	Amount per kg of diet						
		Carot-ine (mg)	Vitam-in A (1) IU	Vitam-in D (IU)	Ribofl-avin (mg)	Niacin (mg)	Panto-thenic acid (mg)	Vitam-in B12 (mg)
Growing/ finishing pigs	5-10	4.40	2200	220	3.3	22.0	13.2	0.022
	10-20	3.50	1762	198	3.1	17.6	11.0	0.015
	20-35	2.64	1321	198	2.6	13.2	11.0	0.011
	35-60	2.64	1321	132	2.2	11.0	11.0	0.011
	60-80	2.64	1321	132	2.2	11.0	11.0	0.011
	80-100	2.64	1321	132	2.2	11.0	11.0	0.011
Gestation	150	6.60	3300	220	3.3	17.6	13.2	0.011
	250	6.60	3300	220	3.3	17.6	13.2	0.011
Lactation	150	6.60	3300	220	3.3	17.6	13.2	0.011
	250	6.60	3300	220	3.3	17.6	13.2	0.011
Boar	150	6.60	3300	220	3.3	17.6	13.2	0.011
	250	6.60	3300	220	3.3	17.6	13.2	0.011

(1) Values given for vitamin A are based on the following relationship: 1 mg of carotene=500 IU of active vitamin A.

The requirements can be met either by carotene or by vitamin A.

22.2.7 Nutrient Content of diets for Pigs.

Nutrients	Live weight class (kg)					
	5-10	10-20	20-30	30-40	40-50	50-60
Gain expected (g)	180	335	400	490	520	540
Crude Protein(%)	18	16	16	16	14	14
Total Digestible Nutrients (%)	70	68	68	68	68	68
Digestible Energy (Kcal/kg)	3100	3000	3000	3000	3000	3000
Calcium (%)	0.8	0.6	0.6	0.6	0.5	0.5
Phosphorus (%)	0.6	0.5	0.5	0.5	0.4	0.4
Common salt (%)	0.6	0.5	0.5	0.5	0.5	0.5

Note:- The ingredients can be replaced by other sources of protein and energy, but the basic formulae should not be allowed to get desired performance in growing and finishing swines

Breeding Pigs:-Breeding pigs can successfully be maintained on diets prescribed for the "finishing" pigs in the body-weight range of 40 kg and above when fed at the rate of 2 % of body weight; lactating sows should be fed at the rate of 3 per cent of body weight, and gestating sows and gilts should be fed at the rate of 1.5 and 2 per cent of their body weight..

(ICAR)

22.3 Feed Additives in Pig Diet

Betafin

Betafin is the trademark of Cultor Ltd., Finnsugar Bioproducts. It is a natural product isolated from plant material.

Role of Betafin in the lean growth of finisher pigs

The feed supplemented with 1-2 kg Betafin per ton significantly reduced the backfat accumulation specially in gilts, but had little effect on growth performance. It also increases the feed conversion efficiency of about 4% for the pig grower. The use of betafin as a substitute for choline and methionine is also beneficial in reducing the cost of the feed.

The feed grade supplement can be used in the proportion of 0.2-2.0 kg feed/ton in piglet diet, while in drinking water 0.1-1.0 kg/1000 l is appropriate. At weaning 2.0 kg/ton feed is recommended for optimum performance. For grower and finishing pigs 0.1-1.5 kg Betafin /ton feed; and 0.1-1.0 kg/1000 litre drinking water is recommended.

22.4 Antimicrobials as Growth Promoters

Antimicrobials are the antibiotics which are used in feed or drinking water to destroy microorganisms present in feed or water and used as growth promoters. The antibiotics are used for therapeutic use and for preventing infection, e.g. sulfonamides, penicillin, nitrofurazone/ nazazolidine, oxytetracycline etc.

Feed antibiotics and antibacterial agents are used to control microorganism e.g. Virginiamycin, moenomycin and Zinc bacitracin. The other compounds which have bacteriostatic property like nitrosin, quindoxin, diametridazole and halquinol.

22.5 Feed Enzymes in Pig Production

Enzymes are protein bio-catalysts which are specific to one type of reaction and, like any catalyst, accelerate the reaction rate. The biological catalysts require mild conditions, operate only within a relatively narrow range of temperature and pH and are rapidly inactivated when environmental conditions fall outside this range.

The enzymes used in pig nutrition are mostly hydrolytic,

breaking down large molecules into smaller ones which the pig can utilize. Enzymes can thus be described as nature's teeth. The primary function of enzymes is to break down plant cell wall polysaccharides to monomers or low molecular weight oligomers, which can be absorbed in the upper digestive tract. This will make it possible to increase the range of lower cost, higher fibre raw materials available to the feed formulator. It also improves the utilization of traditional raw materials such as wheat, barley and soya. The enzymes can also facilitate the release of nutrients otherwise protected by cell walls, the destruction of anti-nutritional factors present in number of raw materials and can supplement the endogenous enzyme production of young piglets which can be limiting.

Numerous studies have shown that additions of fungal or bacterial enzyme preparations to barley diets fed to pigs have resulted in improved digestibility and feed conversion efficiency. Enzymes can be added to pig diets to augment the animal's own capacity to produce protease and amylase when it is thought that such activities are deficient in young piglets.

22.5.1 Why enzymes are essential in piglet ration?

Immediately after weaning, the endogenous enzyme production of piglets tends to fall, limiting the utilization by pigs of energy and protein from untreated cereal sources. The addition of enzymes make it possible to substitute more expensive raw materials like milk products and cooked cereals with cheaper ones like soya and raw cereals.

22.5.2 How to use enzymes in Pig Nutrition ?

There are three methods for inclusion of enzymes in pig's diet:-

1. Direct inclusion

The enzymes are directly added in the diet to work in the gastrointestinal tract. It is the most common method, whereby the dry enzyme premix is added as per any other micro-ingredient.

2. Pre-treatment of raw materials

The enzymes work in the conditioning process to achieve

pre-digestion of the raw materials.

3. Liquid Feeding System

In this method, the enzyme work in the liquid feed.

22.5.3 Characteristics of Good Feed Enzyme

The lack of success of enzymes can for a major part be attributed to the problem of stability. Enzymes are proteins and are very sensitive to heat, pH, heavy metal and other oxidizing agents. Good feed enzymes have to be:

- * Thermostable (through pelleting process)
- * Resistant to proteolytic attack in gastro-intestinal tract.
- * Stable over prolonged storage periods.
- * Active at normal physiological pH.

22.6 Mineral Requirement in Pig Feeding

The calcium and phosphorus are required in large quantity and to be supplied in the diet. The other mineral requirements of pigs are largely supplied by minerals occurring naturally in the feedstuff of the normal diet. These minerals can also be supplied in the form of mineral mixture. The aim of the mineral supplement should be to balance the total needs of the animals with the supply of elements already contained within the diet ingredients. Calcium, phosphorus, sodium and chloride are normally added as ground limestone, dicalcium phosphate and trace mineralized salt. The salt serves as a carrier for trace minerals including iron, copper, manganese, selenium, iodine and zinc. The trace elements are obtained from dietary sources.

22.7 Water Requirement

The water holds a paramount place in its importance in feed. There is a minimum requirement for water without which the welfare of the pig would be adversely affected. The temperature of the environment will influence the water utilization. The frequency of drinking depends upon the dryness of the food and water loss from the body. Lactating sows need to drink more frequently than pregnant sows. It is also required to mix in feed to increase palatability.

22.8 Non-nutritive feed additives

Non-nutritive feed additives are the substances added to

feed for the purpose of improving palatability, improving the texture of meals, prevention of rancidity, preservation of vitamin potency, curing bacterial and parasite infection, preventing infection and for the promotion of growth.

Copper and arsenic compounds have growth promoting effects and is added in the diets of growing pigs. Pigs should not be fed diet containing arsenic compounds 10 days prior to slaughter. Recently it has proved that a combination of synthetic androgen (methyltestosterone) and a synthetic oestrogen (dimethylstilboesterol) have achieved success in promotion of growth. The diet containing hormones should be discontinued 72 hours prior to slaughter.

22.9 Amino-acid in Pig's Diet

Amino-acids are the building blocks of proteins. There are 23 amino acids in nature. These can be further divided into essential and non-essential amino acids. The non-essential amino acids are those amino acids that can be synthesized within the body. Essential amino acids are those amino acids that cannot be synthesized within the body in sufficient amounts to carry out any physiological functions. Therefore, they must be present in the rations in sufficient quantities.

Diets for piglets and growing piglets can show a considerable deficiency in methionine, such a deficiency can be conveniently compensated for by using DL-Methionine Feed Grade.

The amino-acids plays an important role in pig's diet. There are 4 synthetic amino acids, namely, DL-methionine, L-Lysine and Threonine and Tryptophan which are being used in the pig's diet.

23. FEEDING OF PIGS

The feed accounts about 80 % of the cost of raising pigs. Efficient use of feed will ensure the profitable pig production. Efficiency of conversion does not guarantee of profitability achieved by expensive ration. The important point which is to be considered is the cost of feed per kg of pork produced. The feeding of cheaper rations based on locally available materials, may not produce the fastest gain in weight, but will reduce the feed cost per kg of carcass weight gained. Therefore, it is highly important that economical as well as nutritionally balanced diets are provided during all phases of life cycle. The economics of swine feeding are largely dependent on local conditions of feed stuff availability and competition for use by either humans or other animals. The pig has a simple digestive system with limited ability to utilize large quantities of forage like the ruminants. The practical swine feeding consists of meeting the biological needs with proper combination of feed ingredients and pure sources of limiting nutriment to yield an economical and nutritionally balanced diet.

23.1 Feed Stuff

A feed stuff is a component of a diet that serves some useful function. Most feedstuffs provide one or more nutrients. The ingredients are included in the feed to provide bulk, reduce rancidity of oxidized nutrients, to emulsify fats, provide flavour, colour and other factors related to acceptability.

23.1.1 Feedstuffs for the Compound Feed Industry

The ingredients may be classified as follows:

23.1.1.1. High energy sources

Feedstuffs included in this class are those that are added to a ration primarily for increasing energy intake. High energy feedstuffs generally have low to moderate levels of protein. Energy from high-energy feedstuffs is supplied primarily either by readily available carbohydrates-sugars and/or starches or by fat. The various cereal grains like maize, sorghum and cereal by-products like wheat bran, rice polish are included in this class. The other cereal by-products used for are by-products of milling

industry, bakery, starch, glucose, brewery and other industry wastes.

Dried bakery product produced from reclaimed bakery products, candy etc. is an excellent feed as most of the energy is derived from starch, sucrose and fat. It is utilized well by pigs and is a preferred ingredient in starter ration. A wide variety of un-utilized bakery products make very satisfactory feed for animals.

In the breweries, barley is used for the production of beer and the main by-product is the spent grain called the brewer's grain. It is rich in proteins and vitamins and is very suitable for feed industry.

23.1.1.2. Low-energy cereals

Bran constitutes about 10 % of the food grain. Wheat bran is highly palatable and mildly laxative. It is richer in protein, fat and fibre than the whole wheat, but lower in starch. Rice bran is fairly palatable when fresh but often turns rancid on storage because of high oil content. Heating and drying improves the keeping quality of rice bran. The brans are from the outer layers of the seed and contain more protein than the grain.

23.1.1.3. Vegetable Proteins

Oilcakes

Oilcakes constitute an important source of nutrients for all classes of livestock. Oilcakes are generally rich in proteins and are thus used as protein supplements particularly in the rations of growing pigs, lactating sows and sows and gilts in advanced stage of pregnancy. Various oilcakes like groundnut oilcakes, soyabean oilcakes, mustard oilcakes, linseed etc. are included in the feed of the pigs.

By-products of dal milling industry

Pulses and their by-products like chunis or husks which consist of the seed coats with some broken grains obtained in the milling of the legume seeds, are very useful.

23.1.1.4. Animal Proteins

Fish meal

Fish meal is an important ingredient for compounded feeds.

It is used to the extent of 5 to 10 % in the ration.

Slaughterhouse and hatchery waste

The compound feed industry can utilize slaughterhouse and hatchery by-products as raw materials which cannot be normally used because of lack of individual processing facilities.

23.1.1.5. Non-conventional feeds and feed additives

Kitchen waste

The kitchen waste from large hotels, messes and catering establishments set up by Railways, Indian Tourist Development Corporation, Airlines, college canteens, etc. can be utilized for the pig feeds by the feed compounding factories.

By-products of sugar industry

The molasses is an important by-products of sugar industry, which is extensively used by the feed industry. It is a highly palatable and available source of energy.

23.1.1.6. Mineral Supplements

Limestone, bone meal and sea weeds are very rich in minerals and they are used in pig feed.

23.1.1.7. Vitamin supplements

Vitamins are an important and essential components of the diet and therefore should be included in the pig feed.

23.1.1.8. Feed additives

Algae being rich in protein can be successfully added to the pig feeds. Other feed additives like yeast, anti-biotic drugs, molasses, grass or other dried greens forms valuable feed ingredients.

23.2 Feed Resources for Pig Production

Feed is the single most expensive item in pig production and frequently fluctuated from 70% of the cost of pork production to as high as 80% of the cost during certain phases of pork production. Increasing pressures on the World plant and animal resources implies these renewable resources should be utilized ever more wisely and efficiently.

23.2.1 Efficient Feed Utilization by Pigs

Most feed resources used by pigs are fibrous, coarse grains and various by-products. The nutritive value of these feeds vary

from high energy feeds which are 80% of digestible to highly lignified materials which are nearly indigestible. Pigs consuming these low quality feed resources either lose weight or just maintain body weight. The feed conversion efficiency depends upon the quality of feed resources. For production of 91 kg live weight/6 months, 4 kg feed/1 kg gain is required. The efficiency of protein synthesis in the young pigs is considerably higher than in older pigs.

23.2.2 Nutritive Value and Chemical Composition

Feedstuffs are not of constant composition, and individual feed samples may vary widely. Energy values of feeds are frequently influenced by interactions with other feeds, by level of feed intake, and by other management factors.

23.2.3 Availability of Feed Resources

Increase in pig production, necessitated by growing demands, have to result increasingly from forages and by-products for which man does not compete and which do not compete for food-crop land. Pig production can increase by either increasing the quantity and quality of feed or by lessening feed demand by improving the efficiency with which pigs convert the feed or by a combination of both measures. In India, a better use of crop residues and agro-industrial by-products would be beneficial for meeting the demand for animals products. The application of existing and future know-how will lead to rapid increase in availability of pig feed resources and to vast improvements in their utilization by pigs.

23.3 Compound Pig Feed Industry

There is a vast scope for establishment of Compound Pig Feed Industry in India, as Piggery is the most profitable activity amongst all animal husbandry activities.

It is not possible for pig farmers to formulate economical and well balanced concentrate mixture. Different mixtures have to be compounded for different age group of pigs for various stages of production. The particle size of feeds is important for handling and digestion. The compound feed industry can utilize agro-industrial by-products as well as slaughterhouse wastes as

raw materials. The economics of use of compound feeds under village conditions revolves mainly on the price structure of feed constituents and the proportions in which they are compounded.

There is an installed capacity of 3 million MT for feed milling in India. The size of feed mills vary from as small 5 MT to as large as 600 MT/day. Modern scientific methods like computerized formulation, process and inventory control, sophisticated laboratory facilities and skilled technical workers are available in the country. All the feed plant machinery are manufactured indigenously. BIS standards are available for raw materials and feeds. However, feeds produced in different parts of the country do not confirm to the BIS quality standards. The shortage of feed ingredients owing to export market is also forcing the feed manufacturer to sacrifice the quality. Most of the feed milling industry produce cattle and poultry feed. The pig feed is produced in very small quantity. It is essential to establish pig feed industry near area of pig production for easy availability at economic price.

23.4 Pig Ration

23.4.1 Characteristics of a Good Ration

A good ration should provide nutritionally based diet according to the changing nutritional requirement of animal through out the life cycle.

- ☐ A good ration should be nutritionally balanced.
- ☐ It should be palatable and safe.
- ☐ It should be adapted to the system of farming.
- ☐ It should be economical.
- ☐ It should be readily available.
- ☐ A good ration should be adapted to the environmental conditions.

23.4.2 Feed Stuffs for Pig Ration

23.4.2.1. Cereal Grains and By-products

The cereal grains and many by-products constitute a larger percentage of an important constituent of the ration. The addition of cereal grains and their by-products helps in raising level of protein, minerals to the level required by the pigs. Most of the

cereal grains and their by-products are palatable to swine. The by-products are available on cheaper rate. The palatability of cereal based products can be increased by processing, i.e., heat treatment, mixing with other feed stuff, cooling etc. The costly products are added to the ration to the limit of appetite. The selection of cereal grains and by-products can be done according to the availability and cost and quantity of nutritive value.

23.4.2.2. Milk, Animal and Marine By-products

Cereal grains and other type of feed stuff must be supplemented with milk, animal and marine by-products for increasing the quality of feed stuff for gaining more feed conversion efficiency.

The milk products contains the excellent high quality of protein, vitamins and minerals and milk sugar i.e. lactose. Dried skim milk, dried butter milk, dried whey, cheese rind and dried whey soluble are best for young pigs.

The modern meat packing plant by-products, slaughter house waste, marine products are the important sources of swine feeds. The by-products of the poultry dressing plants and hatchery waste can be processed and fed to pigs. These products can be processed to form a very cheap and highly nutritive diet for pigs.

The marine based feed stuff provides pigs a clean, highly nutritive feed supplement. These include fish meal and fish residue meal. These products are excellent sources of several vitamins, high quality protein.

23.4.2.3. Feeds of Plant origin-Forages

The digestive system of the pig is not well adapted for digesting very fibrous and bulky foods. A large proportion of the ration must consist of materials with a low fiber content. However, addition of forage may be advantageous as they are the excellent sources of essential vitamins and minerals. They permit the animals to have access to iron rich soil which aids in anaemia prevention.

23.4.2.4. Locally available Resources

The compound rations and ready-to-feed products are costly

and not in the reach of small farmer. It is possible to make better use of locally available feed crops, offals and by-products, hostel and kitchen wastes from hotels and Dhabas etc. The other locally available resources includes bakery waste, damaged bananas, blood meal, bone meal, wheat and rice bran, vegetable and other fruit waste, cassava, carrots, coconuts, distillery by-products, hatchery waste and sugarcane industry waste.

23.5 Scales of Rations for various stages of Cycle

The ration should be formulated in such a way that it provides all essential nutrients and is economical and palatable. The ration should be given according to the body weight and stage of the life cycle. The scale of rations according to the body weight and stage of production cycle is given in Table 23.5.1.

23.6 Feeding during various phases of Life Cycle

23.6.1 Sows and Gilts for Breeding

During the breeding season gilts and sows in dry lot will gain about 0.5 kg a day if they receive 0.75 kg to 1.0 kg of concentrates daily per 50 kg. of the live-weight. With gilts being served during their second or third heat periods, flushing is possible for the last 10 days before service and during this period the feed should be increased to 3.5 kg per day. Flushing for this period of time increases the ovulation rate and this can increase the litter size by one or two piglets. This level of feeding is maintained for 2 days after service to ensure that ovulation is completed. The level of feed can be reduced to 1.8 kg per day and continued until the stage of pregnancy.

23.6.2 Pregnant Sows and Gilts

The feeding scale for pregnant sow will depend upon the size of sow or gilt, desired rate of growth and stage of pregnancy. There is a need for a sow to gain weight in pregnancy to protect the depletion of maternal body, and for good lactation. The obesity in sows is not desirable as it reduces the embryo and fetal survival, creates problems at farrowing and lactation. The deposition of the excess fat also increases the maintenance cost.

Table 23.5.1 Scale of Rations as per Body Weight

1. Starter (body weight 10-20 kg)							
Body weight (kg)	10		15*		20		
% of ration for 15 kg starter	80		100		120		
2. Grower (body weight 20-50 kg)							
Body weight (kg)	25	30	35*	40	45		
% of ration for 35 kg grower	83	91	100	111	120		
3. Finisher (body weight 50 -90kg)							
Body weight (kg)	55	60	65	70*	75	80	85
% of ration for 70 kg finisher	87	91	96	100	105	110	120
4. Pregnant sow (body weight 120-200 kg)							
Body weight (kg)	120		160*		200		
% of ration for 160 kg sow	83		100		115		
5. Lactating sow (body weight 120-200 kg)							
Body weight (kg)					120	160*	200
% of ration for 160 kg sow							
Piglets in litter				6	71	85	95
				7	75	91	105
				8	80	96	110
				9	83	100*	115
				10	85	102	117
				11	86	103	118
				12	87	104	120

23.6.3 Lactating Sows

Feeding of lactating sows depends upon the productive capacity of the milk, size of the litter, weight and age of the sow. The lactation ration should make allowance for the next conception.

23.6.4 Feeding of Piglets

The lactating sow is a supremely competent mammal which efficiently converts dietary nutrients in the milk. It is important for her to support a gain in then live weight of her litter of 2.5 kg /day during the first three weeks of lactation. Colostrum (first milk) should be fed to piglets for protecting them against disease.

It is a common commercial practice to offer feed to piglets while they are still with the sow in a creep area. The composition and amount of creep feeding differ according to the length of the suckling period. Early weaning is a relative term and is usually taken to refer to weaning between two and four weeks of age. There are three types of approach for feeding of early weaned piglets. The first approach is to design diets to be as similar to sow's milk as possible but in the dried form and should be fed *ad-libitum*. The second approach is to feed an inferior diet but to restrict the amount of feed, particularly in the first few days after weaning. The third approach to early weaning diets is virtually to find to balance between cheap constituents and the addition of anti-bacterial agents.

23.6.5 Feeding of Growing Pigs

Pigs require more feed daily for maintenance and for growth. The appetite increases with size as well as the rate of fat deposition. For reducing the maintenance of the pig, it is important to restrict the appetite. It will also help in reducing the fat deposition.

The ration scale for growing pigs will depend on individual circumstances, economics, type of carcass desired. Young pigs can benefit from *ad-libitum* feeding. *Ad-libitum* feeding has also advantage in terms of labour use and simplicity of management. However, the growth obtained may be rich in fat. Therefore, rationing by weight and by time plays an important role in

reducing the cost of rations and to gain carcass which is more in lean meat than fat. Pigs can be weighed regularly and allocated their appropriate ration.

The rationing for different sexes influences their rates of deposition of lean meat. Thus the maximum rates for daily protein deposition has been suggested as 90 g, 120 g and for castrates, gilts and boars respectively.

23.6.6 Feeding Weaned Sows for Re-breeding

The condition of the sow at the end of reproductive cycle when her piglets are weaned is the result of the combination of pregnancy, feeding, lactation feeding, milk yield and body condition. If these stages are managed properly there will not be any problems in re-breeding of weaned sows. Normally, sows will show oestrous four or five days after weaning.

23.6.7 Feeding Boars

Young boars are normally ready for service at around 7 months of age to start with they should be used for a single service once or twice a week. For mature boars four or five services evenly spread per week is possible. For a average size boar the daily feed requirement is between 2.4 to 3.4 kg of meal used for lactating sows. Underfeeding can reduce the boars fertility and over feeding will increase live weight and reduce its libido.

23.7 Methods of Feeding

In modern intensive pig production, the method of feeding and feeding equipments affects productivity. Feeding method should be chosen according to the aim of the production of meat, rationing system, form of feed and type of feed stuffs available.

23.7.1. *Ad libitum* Feeding

Diets which are based largely on bulky feeds can be fed *ad-libitum* because the pigs capacity will limit their energy intake. It is a labour saving in operation and allows the pigs to fulfill their full growth potential. The *ad-libitum* feeding may cause a lot of food wastage, and the efficiency of food conversion is somewhat low. The finisher carcasses tend to be rather fat. The young animals are fed *ad libitum* up of 45 kg body weight.

23.7.2. Restricted Feeding

The ingredients are mixed together before feeding to form a complete diet. These diets can be fed dry, as a meal or pellets or wet, either by the addition of water to the feed in the trough at feeding time or preparing in liquid form.

The animals are given a measured amount of feed once, twice or three times a day. In this feeding the growth is restricted, but feed conversion efficiency is improved. The quality of animals becomes better by lean meat deposition. In ration feeding, there is a saving on wastage.

23.7.3. Appetite Feeding

In this system, the combination of *ad libitum* and ration feeding is applied. The pigs are given as much as food as it is thought they can clear up in 15 to 20 minutes and if some is left over the next feed is made smaller. If, all is cleared well before the end of 20 minutes extra food is provided next time. This system is supposed to give excellent growth rates without the laying down of too much fat in the carcass.

23.8 Form of Feed

23.8.1. Fine or Coarse Grinding

The reduction in the particle size increases the digestibility of many ingredients specially plant materials. But, very fine grinding of some ingredients, particularly cereals increases the incidence of stomach ulcers.

23.8.2. Meal or Pellets

The cost of the pelleted feed compared to meal type rations will largely determine the economy of this method of preparation for swine feeding. The pellets feeding improves performance by reducing food wastage and by increasing digestibility.

23.8.3. Wet or Dry Feed

Wet feeding also reduces food wastage and may also increase digestibility. Wet feeding means mixing of dry complete feed with 2-3 times its weight of water in the feeding trough. It gives slightly better food conversion and growth rate than dry foods alone. In dry feeding there is slightly less wastage and can be successfully used for *ad-libitum* and rationed feeding.

23.9 Mixing, Storage and Feeding

23.9.1 Mixing

The simplest way of mixing a diet is with a shovel on the ground. Turning the mixture over six times will give mixing complete. For larger quantities and more regular mixing, a simple manual cement mixer is very suitable. Specialized feed mixers are also available but costly.

23.9.2 Storage

The feed ingredients should be stored under cover and in vermin proof containers. It should be kept away from the walls and above from the ground level. The ingredients should be stored in dry form, as the wet feeds deteriorate rapidly and also very attractive to vermin.

23.9.3 Feeding

23.9.3.1 Feeding Equipments

The equipment for feeding needs to be well designed to allow pigs good access to the feed but eliminate feed wastage. For feeding a ration, troughs of brick, concrete or sheet metal are also suitable. For sows and boars a single large trough each is best. For self feeding hoppers or sheet metal are best. Self feeders also promotes sanitation and provides large feed storage space. However, these are expensive. A good self feeder should be available to the pigs for the supply of clean, dry feed at all time. For liquid feeding liquid food troughs and pipes carrying liquid foods can be installed.

23.9.3.2 Fermented Liquid Feed for Pigs

British research conducted over the last four years at the University of Plymouth's Seale Hayne Faculty suggests that fermented liquid feed (FLF) has the potential to replace antibiotic growth promoters. Liquid feed is fermented using lactic acid bacteria, which acidify the liquid feed and the acid conditions that prevent the growth of potential enteropathogens like salmonella and *E. Coli*. The research demonstrated that weaned pigs take readily to FLF and the growth rates are superior to those of pigs fed dry pelleted diets post weaning. Copper sulphate can be used in FLF without harming the fermentation.

23.9.3.3 Cooking Boosts Performance

Significant improvement in performance of piglets during the critical 7 days after weaning have been achieved through the use of diets containing steam cooked cereals. These experiments showed a 47% increase in daily liveweight gain, from 119 to 175g and a 0.52 improvement in feed conversion ratio, from 1.71 to 1.19. The enzymes which digests starch in the piglets digestive system is not well developed at this stage. Cooking cereals 'pre-digests' the starch making it more available to the baby piglet. This is particularly beneficial for very small pigs, thus lowering the cost per kg of liveweight gain.

23.9.3.4 Sugarcane Juice as feed for pigs

Sugarcane juice is composed almost entirely of carbohydrates in the form of sugar, thus the use of protein supplements throughout the production cycle is essential. The research performed at Faculty of Veterinary Medicine and Animal Husbandry of the University of Yucatan, Mexico showed that sugarcane juice increases the feed conversion efficiency in pigs. They also used fresh and preserved juice, and significant differences were observed, the highest weight gain was observed with preserved juice.

Preserving sugarcane juice

Sugarcane juice ferments within 10 to 12 hours, depending on the temperature and pigs will not consume fermented juice. The use of additives, however, can help to slow the fermentation process. The juice can be preserved for up to 72 hours with formalin at levels of from 0.01 to 0.06 percent; up to 6 days by using ammonium hydroxide at a level of 1.5 percent; and up to 7 days using 1.5% sodium benzoate.

The use of sugarcane juice during pregnancy, not only increased the conception rate but piglets weighed more both at birth and weaning.

23.10 Feed Formulations

In India, compound feed for pigs is not available in the market. Therefore, it is necessary to know the different feed formulations for various stage of life cycle of pigs.

23.10.1 Creep and Starter Ration(2-15 kg body weight)

Ingredients	American	British	Indian creep mixture
Rolled Oats	50		
Soyabean	20		
Maize Meal	15		
Barley Meal		22	
Wheat offal		20	
Flaked Maize		20	
Wheat bran			10
Ground Yellow Maize			40
Groundnut cake			10
Til cake			10
Skimmed Milk		15	10
Fish Meal	2.5	15	6
Dried Whey	2.5		
Sugar	7.5		
Molasses			10
Dried Grass		5	
Brewer's yeast		3	2
Mineral mixture	2%	2%	2%
Vitamin Supplement	10 gm	10 gm	10 gm

Note: The piglets can be fed with one of the above three formula depending upon the availability of ingredients.

23.10.2 Grower Ration (45-90 kg body wt)

23.10.2.1 Cereal based Ration

Ingredients	Ration-I	Ration-II	Ration-III	Ration-IV
Maize	30	20	60	20
Groundnutcake	20	10	10	10
Wheat bran	40	40	10	12
Til cake		10	10	10
Milo		10		15
Any other grain				15
Rice polishings				10
Fish meal	7.5	7.5	7.5	7.5
Mineral Mixture	2.5	2.5	2.5	2.5
Rovimix (A+B2+D3)	10 g	10 g	10 g	10 g

23.10.2.2 Non-cereal based Ration

Ingredients	Ration-I	Ration-II	Ration-III	Ration-IV
Wheat bran	70		60	
Groundnut cake	20	20	20	20
Rice polishings		70		60
Milo			20	
Yellow Maize			10	10
Fish meal	7.5	7.5	7.5	7.5
Mineral Mixture	2.0	2.0	2.0	2.0
Common salt	0.5	0.5	0.5	0.5
Rovimix (A+B2+D3)	10 g	10 g	10 g	10 g

23.10.3 Finisher Ration (45-90 kg body weight)

23.10.3.1 Cereal based Ration

Ingredients	Ration-I	Ration-II	Ration-III	Ration-IV
Maize	40	25	20	25
Wheat bran	30		20	15
Groundnut cake	12	12	12	12
Til cake	10	10	10	10
Milo			20	
Any other grain		15		15
Rice polishings		30	10	15
Fish meal	5.5	5.5	5.5	5.5
Mineral Mixture	2.5	2.5	2.5	2.5
Rovimix (A+B2+D3)	10 g	10 g	10 g	10 g

23.10.3.2 Non-cereal based ration

Ingredients	Ration-I	Ration-II	Ration-III	Ration-IV
Wheat bran	75	70	50	40
Groundnut cake	17	12	17	12
Til cake		10		10
Rice polishings			25	30
Fish meal	5.5	5.5	5.5	5.5
Mineral Mixture	2.0	2.5	2.5	2.5
Common salt	0.5			
Rovimix (A+B2+D3)	10 g	10 g	10 g	10 g

23.11 Feeding of Soybean to Pigs

Soybean meal is an important source of energy and protein for pig feeds. The discovery that swine need amino acids and not protein has led to the increased utilization of soybean meal. It has the best balance of essential amino acids of all the vegetable proteins. The bioavailability of its amino acids is also the highest of vegetable protein sources. It is highly palatable and available year-round at a reasonable cost.

23.11.1 Fullfat Soybean Meal

The use of fullfat soybean meal (FFSBM) in animal feed was first studied in the 1960s. The level of linolenic acid, an essential fatty acid, is 8.5% making it an excellent source of this needed nutrient. Linoleic acid, the first essential fatty acid is supplied by full-fat soybeans (56%). It was found to be a valuable feed ingredient because of its high oil and protein content.

High quality FFSBM is an excellent source of energy, protein, linoleic acid, vitamin E and lecithin and can be fed to all stages of life cycle of pigs. Its use depends on the relative price and availability of soybean meal and feed grade fat compared to whole soybeans and access to and cost of processing equipment. Soybeans have to be processed before they can be used as feed ingredient for pigs to remove the anti-nutritional factors. When soybeans are treated by application of heat without removal of oil, the product is known as FFSBM.

23.11.2 Anti-nutritional Factors

The raw soybeans contains large number of anti-nutritional factors such as protease inhibitors, hemagglutinins, saponins, goitrogenic factors and metal chelating factors. These factors affect pigs performance when fed untreated. These factors can be destroyed by following methods:-

1. Cooking and autoclaving

The beans are boiled for at least 30 minutes and then dried. The treated beans can be fed to pigs whole or can be ground into meal. In autoclaving, steam under pressure is used, but this method is costly.

2. Micronization

The beans are cooked using infra-red radiation with wavelength of 1.8 to 3.4 microns. Radiation is emitted when ceramic tiles are heated. The radiation is absorbed by soybean molecules which vibrate, thus generating heat in the process. The high temperature of 180-220°C increases the digestibility of complex carbohydrates and destroys the anti-nutritional factors.

3. Roasting

This process involves the cooking of beans using dry air with a temperature varying from 110-170°C, depending on the type of equipment deployed. The methods of roasting includes saltbed roasting, heated ceramic roasting, rotary drum dryer to common grain dryer. Most of these methods use direct fire which gives rise to variation in the degree of cooking. The variation can be minimized by use of modern fluidized bed roasting system.

4. Extrusion

In this process, whole or ground beans are forced through a barrel using a screw with variable configurations and are allowed to pass through a die at the end of the barrel. The basic principle of extrusion process is “HTST” (High temperature, short time). The material is subjected to heat, pressure and shear forces. The friction and shearing and the pressure changes in the extrusion process rupture oil cells, rendering the oil more available to digestion.

Soybeans can be processed using a dry or wet extruder.

(a) Dry Extrusion

Dry extruders are single screw machines designed for the processing of whole or ground soybeans. The heat and pressure generated in the extruder barrel typically raises the temperature to 138-150°C, which destroys the anti-nutritional factors of the soybeans.

(b) Wet Extrusion

Recent findings have demonstrated that stem preconditioning enhances the efficiency of extrusion. The wet extrusion reduces wear and tear of the machine, enhances

inactivation of anti-nutritional factors and improve the biological value of the protein of FFSBM.

23.11.3 Soybean Feeding for Pigs

FFSBM for Young Pigs

It is an important feed ingredient for young pigs due to the following attributes:-

- * high protein content with a well-balanced amino acid profile.
- * high oil content with more than half consisting of linoleic acid which is an essential polyunsaturated fatty acid.
- * good mixing property as a feed ingredient.
- * control of dustiness.
- * excellent smell and palatability.

In recent study, Kim *et al* (1995) reported that extruded whole soybeans improved the performance of growing pigs. The initial average body weight was 50.8 kg and the final average weight was 113.4 kg. The average daily gain increased by 5.5% as the level of FFSBM increased from 50% to 100%. The feed efficiency improved by 12.4% as the level of FFSBM increased from 0% to 100%.

FFSBM for Sows

Recent studies have shown that addition of FFSBM to diets of sows in late gestation and early lactation increased the number and weight of weaned piglets. Crenshaw (1983) showed that anti-nutritional factors in raw soybeans had no detrimental effect on sows.

Feeding of Raw Soybean to Pigs

Older pigs can tolerate anti-nutritional factors present in raw soybeans to a moderate degree. Bitney and Danielson (1984) conducted a study using 25% raw ground full-fat soybean meal in gestation diets to replace 16% soybean meal and 9% corn. There was no significant effect on weight loss in lactating sows or the individual piglet weights at weaning. With gilts, the raw ground full-fat soybean meal group consumed 10% more energy and farrowed 10% more piglets than those on the conventional soybean meal diet.

23.11.4 Practical swine diets containing FFSBM

The practical swine diets containing FFSBM for different age groups are given in Table 23.11.4.1.

Table 23.11.4.1 Swine diets containing FFSBM

Ingredients	Starter 8-30 kg	Grower 30-60 kg	Finisher 60-100 kg	Pregnant	Lactation
Corn	50.2	41.5	52.8	52.0	39.1
Soybean Meal	8.1	8.3	14.2	4.0	0.0
Full fat soybean meal	20.4	26.4	10.0	9.8	29.7
Fish meal	5.0	0.0	0.0	0.0	0.0
Wheat poll	5.0	10.0	12.0	15.0	15.0
Rice bran	8.0	10.0	7.8	15.0	12.0
Limestone	1.46	1.74	1.42	2.27	2.19
Mono-dicacium phosphate	0.90	1.08	0.93	0.93	1.05
Salt	0.43	0.48	0.41	0.48	0.47
Vitamin Mixture	0.50	0.50	0.50	0.50	0.50
Lysine-HCl	0.06	0.10	0.10	0.0	0.0

24. WATERING FOR PIGS

Water plays an important role in pig industry. Quality is very important not only preventing infection, but also to check the harmful effects of pollution.

24.1 Status of Groundwater

The environment in equilibrium is the most vital factor for existence of animal life on the earth. The great increase in population, the onset of industrialization and numerous irrigation demands have resulted in sharp rise in consumption of water and its over exploitation. The increased growth of industrialization and expansion of productive agricultural land with a deterioration in quality of water.

24.2 Provision for Safe Drinking Water for Pigs

Before establishment of Pig farm, water quality should be tested. If the water is not fit for drinking to human population, it should not be supplied to pigs without treatment. There are number of processes available for making water safe for drinking. These includes precipitation, removal of pollutants due to oxidation or reduction, mechanical filtration, biological degradation and membrane filtration etc.

24.3 Water requirements for pigs

The water requirements for pigs is influenced by age, sex, stage of life-cycle and temperature of the environment. The approximate water requirement of pigs is given in table 24.3.1

Table 24.3.1. Water requirements for pigs

Stage of life-cycle	Minimum water (Lit/day)	Minimum frequency of water provision (Times/day)
Suckling piglets	ad libitum	Freely available
Weaned piglets	ad libitum	Freely available
Growing pigs (20-90 kg)	1-6	Once or twice
Pregnant sows	4	Once or twice
Lactating sows	12-21	Twice but preferably freely available

25. CLEANING, DISINFECTION AND HYGIENE

Cleaning, disinfection and hygiene helps in limitation of infection. Disinfectants act in one of three ways (i) as oxidizing agents or reducing agents; (2) as corrosives or coagulants acting upon the protoplasm of bacterial life; or (3) as bacterial poisons. These helps in reducing the predisposing factors for a disease and increases the production at pig farm.

25.1 Cleaning and Hygiene of Pig Sheds

Cleaning and disinfection plays an important role in maintenance of hygiene at piggery farm. Hygiene not only prevents spread of diseases but also increases the production efficiency at farm. There are several important steps involved in day-to-day cleaning and maintenance of hygiene, which are as follows:-

Cleaning of pigs and sheds is done with the detergents.

Detergents

Detergents are the substances which cleanse by lowering the surface tension of water and cause it to spread over a surface rather than remain in droplet form. Detergents includes soap, washing soda and many new synthetic compounds analogous to soap but derived from alkali and petroleum rather than from alkalis and vegetable or mineral oils. They are used to clean the sheds and bathing of pigs. These not only remove dirt and feces but also increases the production efficiency at pig farm. One time cleaning with detergents is essential. A jet of water generating from a electric operated motor can be used for efficiency. During summer months, two time water bathing of pigs can be done, morning with soap and water and evening with only plain water.

25.2 Disinfection

Disinfection is the process of rendering animal house, piggeries etc. harmless, free from infection by the use of either physical or chemical disinfectants. Disinfection is a very important precaution in pig industry. Besides other modern technologies in animal husbandry and pig production as well as veterinary science, accurate know how in the use of

disinfectants plays a vital role in farm economics. The use of right disinfectant specific to a particular microorganism (disease germ) might help to reduce economic loss due to wide spread of the disease in pig farm.

Disinfection by its meaning is the destruction of all of the active pathogenic microorganisms. It can be divided mainly to natural source disinfection which is principally heat and radiation from the sun light; and man-made disinfection. Disinfection can be achieved through great variety of mechanical devices generating pressure, heat, radiation etc.; and chemical agents which are called “disinfectants”.

Definition

“Chemical agents applied to objects to kill microorganisms i.e. bacteria, fungi viruses and protozoans”.

Characteristics of Good Disinfectant

- o Destroy microorganisms rapidly.
- o It should not have corrosive property or discoloring property.
- o Non-toxic for human and pigs, not causing pollution or alter ecological environment.
- o Readily available and cheap in price.

Properties and Action

The activity of chemical disinfectant Is dependent on concentration, time, temperature and the nature of the material or surface to be treated. Chemical disinfectants operate against microorganisms either by:

- Destruction of microbial cells (lysis).
- Inactivation or disorganization of genetic material, metabolism of microbial cells, so that replication of the microorganism is prevented by inducing protein coagulation, altering protein property, altering essential membrane transport system, inhibiting cellular utilization of metabolites or enzymes.

Use of Disinfectant

Routine treatment as part of farm security procedures
e.g. farm entry/ exit of vehicle and or workers concerned.
Routine treatment as part of hygiene management e.g. pig

pen disinfection prior to getting the pigs in and after the pigs have been moved out.

Control procedures following a disease outbreak or disinfection of premises after death of confined pig.

Decontamination procedure following major exotic disease outbreak.

Cleaning and Disinfection

As being the most common practical, using of disinfectant is often the only available way of dealing with pathogenic microorganisms in a piggery farm

Points for Using Disinfection

- ☐ When using disinfectants; concentration recommended as well as other instructions viz. time interval for the application, temperature of the solution prepared etc. should be followed strictly.
- ☐ Cleaning of surfaces by the proper pre-disinfectant agent i.e. 4% soda ash solution will increase the effective destruction of viruses and bacteria in the contaminated area.
- ☐ All manure and litter must be removed, dirt floors be scraped down, any material such as wood that cannot be thoroughly cleaned be removed. The removed material should be buried or burnt.
- ☐ Construction sites be thoroughly cleaned e.g. ceilings, floors, walls and all other surfaces; all equipment used in material removal- such as manure loaders, shovels, brushes and scrapers, be thoroughly cleaned.
- ☐ An over all rinse be given to all cleaned facilities and equipment with clean water, following with the application of appropriate disinfectant.

25.3 Dipping

This method is used most extensively for destruction of ecto-parasites of pigs. In every case it is advisable to consult the local veterinary doctor as to the dip to be used for treatment of particular parasite. The bath to be used depends on many circumstances, such as numbers to be dipped, land and material available and so on. The well may be made from concrete with

the breadth at top 3 feet 5 inches; breadth at bottom 2 feet 6 inches; depth of well 5 feet 9 inches; Length at top 30 feet and length of well 20 feet; entrance slope 5 feet; exit slope 10 feet and depth of dip from bottom should be 4 feet for the pigs. As the dip may not act on the eggs, the dip must be repeated at suitable intervals, i.e. 3-4 weeks and against mange in about 7 to 10 days.

25.4 Spraying

Dipping of pigs involves considerable trouble, and most cases is static so static so that pigs must come to the dipper. The use of modern sprays and jet, whereby the chemical agent is directed on to the pig's skin with considerable force. The only disadvantage is that if a patch is left un-sprayed is remain vulnerable.

25.5 Method of Composting Pig feces

Waste disposal of pig feces is one of the important decision which have to be taken very early in planning a pig farm. For a small unit on a mixed farm the fertilized value of the wastes is an asset, rather than a problem. However, for bigger units, particularly in specialized farming with less land holdings the disposal of wastes can be used for producing methane.

The pig feces can be dried to be supplied as manure for fruit and vegetable growers. Ten pigs produces approximately 30 kg of dung and 75 kg of liquid waste.

The effective way of waste disposal is through bacterial breakdown in a settling tank in the absence of air. In a closed airtight chamber, methane gas is produced which could be used for cooking, heating and for other farm activities. This process works rapidly and efficiently in summer season. But it stops working during winter. It is possible to use some of the gas produced to warm the fermenter.

25.6 Disposal of Dead pigs, litter etc.

Carcasses of pigs that have died from the disease must be removed and disposed in proper manner to prevent the spread of disease to other pigs.

25.6.1 Disposal of Dead carcasses

Carcass of pigs may be disposed of by burial or burning. They should not be left lying for any length of time in summer weather. For burial of carcasses, a site should be selected where there will be no danger of pollution of rivers, canals or other water supply. A pit is dug, about 8-9 feet deep, in such a manner that surface soil and subsoil are not mixed. Roughly about 1 square yard of surface is required for each pig. The dead pig should be arranged upon its back with the feet upwards. The carcass is next covered with quicklime or a powerful disinfectant and the pit filled in with the soil, subsoil first and surface soil last. The pit should not be opened or ploughed before 6 months.

The surface burning method is used where there are number of pigs to be burned. One long trench is dug about 1 foot 6" deep and 1 foot wide, and about 2-3 feet in length is allowed for each carcass. At intervals along each side there are placed side flues to coincide with each carcass. Fuel like straw, wood and coal is placed around the central trench and carcasses are drawn across it. More fuel is heaped around and between them, and paraffin oil or petrol is sprayed over the whole. The straw is lighted. More fuel requires to be added at intervals. The surface of the soil around the edge of the pit, upon which the carcass rests, should be scraped off and thrown into the fire or pit so that any blood or discharges may be rendered harmless.

25.6.2 Disinfection of Building and equipments

Everything that has come into contact with the carcass must be carefully disinfected before it is removed.

All the workers handling diseased carcasses should be made to wash their hands and arms with disinfectants and to dip his feet into a pailful of disinfectant, before they leaves the place disposal.

Building must now be thoroughly scraped, brushed and cleansed. Concrete floors may be power-hosed, scraped free from all dirt and debris. A hot detergent solution of 2.5 to 4% washing soda is then thoroughly scrubbed onto floors, walls, stall partitions, mangers, troughs, or other fittings.

For fumigation of building, all air entrances and exits are securely closed. The inside of the walls and roof is soaked with water, and formaldehyde gas generated by pouring on to 250 gm of potassium permanganate 500 ml of formalin per 1000 cu ft. of air space. All windows are left shut for 24 hours, and the building is then flushed out with clean water under pressure from a hose-pipe.

All grooming tools, shovels, forks and other equipments etc. which have been used by the infected animals must also be disinfected before they can be considered safe for further use.

26. PEST CONTROL IN PIG FARMS

Pests are the most persistent and damaging to any farm and are of extreme economic importance. Pests are especially harmful to man and pigs as carriers of disease. They transmit diseases like salmonella food poisoning and tape worm infection.

26.1 Why Pest control?

Pests not only disturb pigs in their normal physiological activity and behavior but also helps in spread of diseases like parasitic diseases and other infectious diseases. Therefore, it is very important to control pests in any piggery farm. The sarcoptic mange in pig is very common in pigs, it starts on the head and gradually spreads all over the body especially attacking the thinner skin. It leads to intense itching, and falling of hairs and skin becomes covered with scabs or wart like projections. It can be controlled by BHC preparations spray.

26.2 Pesticides

Pesticides are the chemical substances, which are used to control pests. Pests are those living organisms, thought to be harmful to human interest. The term pesticide is an all-embracing word for herbicides, which kills plants; insecticides, which kill insects; and fungicides, which acts on fungi and so on. Most pesticides are poisons and aim to kill the target species.

26.3 Types of Pesticides

Pesticides are used worldwide and in a wide variety of habitats. Natural organic pesticides, such as pyrethrum, and inorganic substances, such as copper sulphate in Bordeaux mixture, as applied to vines, have been used for centuries. But at present, about 90% of the pesticides are synthetic. The classification of pesticides is based on their action.

1. Contact

These penetrate through the cuticle of insects.

(a) Natural

Nicotine, which is developed from tobacco, pyrethrum, which is extracted from the flowers of *Chrysanthemum sp.* and rotenone, which is extracted from the roots of Derris are the natural insecticides.

(b) Synthetic

These compounds are now widely used and are constantly being modified as resistant strains are built up as a result of selection. e.g. DDT, gammexane, parathion, malathion etc. These insecticides are used as spray to kill flies, bacteria etc. DDT is very persistent in soil and very toxic and its use is banned in some countries and replaced by organophosphates like parathion etc.

2. Systemic

These compounds are absorbed through the alimentary canal. Newer insecticides interfere with the transmission of nervous impulses. Some of the contact poisons have been used as systemic insecticides, e.g. parathion, DDT. These are used against insects and ectoparasites of pigs.

3. Fumigants

These compounds are used as fumes and destroy insects. These are used in cleaning of farrowing house and killing of insects. These compounds are used in pig sty before shifting of animals. e.g. Formaldehyde etc.

26.4 Toxic Effects of Pesticides

It may affect the pigs and human workers of the farm. Toxicity may lead to loss of non-target species like birds etc.

26.5 Precautions when handling pesticides

Absorption of insecticides or rodenticides occurs in man and animals. Each exposure, no matter how brief or small, results in some of the compound being absorbed and perhaps stored. Repeated short exposures may eventually result in intoxication. Following precautions should be taken to minimize exposure.

- o Use rubber gloves, respirators, rain gear or frequent changing of clothing, with bathing at each change.
- o Respirators must have filters approved for the type of insecticide being used.
- o In no case, the amount greater than those specifically recommended be used.
- o Maximum precautions must be taken to prevent drainage to adjoining fields, pastures, ponds, streams or other premises

outside the area in which the treatment is essential, to protect the wildlife and fish.

26.6 Biological Control

Biological control of pests have traditionally meant regulation by natural enemies; predators, parasites and pathogens. It is a form of population control preventing unchecked exponential growth of pest species.

26.7 Fly Control Measures

Flies can be controlled by dipping, spraying and the use of simple fly traps.

26.7.1 Spraying

Spraying of Insecticides

A suitable insecticide may be used in piggery farm. The spraying can be carried out with a knapsack sprayer which may be hand-operated or engine-operated. It is not sufficient to spray only buildings occupied by pigs, since many flies rest in other farm buildings-on walls, beams and ceilings. Insecticides must not be used indiscriminately, but strictly in accordance with the instructions and precautions given on their leaflets by the manufacturers, and bearing in mind hazards to farm workers and risk of contamination of pig feed and drinking water etc.

Plain Water Spraying

It is possible to reduce the number of flies entering a building by means of plain water emitted from a perforated hose or a spray boom erected over doorways. A plain water mist, from ordinary sprinklers or misters, has been very useful in pig farms.

26.7.2 Painting of Varnish with insecticide

The application to the interior walls, above head height, of a varnish containing a phosphorus insecticide with a sweet bait proved very successful for control of flies. Three to five applications are necessary per season.

26.7.3 Electronic Fly Traps

Electronic fly traps can be successfully used in pig farms.

26.7.4 Fly repellants

The fly repellants have been tried in many countries over

many years, but frequent renewal is necessary.

26.8 Rodenticides

The chemical substances which are used against rodent pest, are called rodenticides. Rodents not only eats pig's feed but also helps in spreading of many diseases. It is very important to control rodents by proper use of rodenticides.

Anticoagulant rodenticides

The commonly used anticoagulant rodenticides includes Warfarin and congeners which competitively antagonize vitamin K, which causes an interference with the normal synthesis of coagulating proteins in the liver, thus adequate amounts are not available to convert prothrombin into thrombin.

Toxicity in pigs

Intoxication in pigs largely have been the result either of contamination of feed with warfarin concentrates or by feed mixed in equipment used immediately before hand to prepare rodent bait. Poisoning in pigs is caused by repeated low doses or single massive dose of 3 mg/kg for 7 days.

Zinc Phosphide

Zinc phosphide has been extensively used around pig farms and barns because rats tend to die in the open-an esthetic advantage.

27. DISEASE CONTROL AND HEALTH

Disease is an important cause of low profitability in pig production. Pigs are susceptible to a number of diseases, which affects their appetite, growth, feed efficiency and their ability to reproduce and give milk. An efficient husbandry system should act as a barrier to the introduction of diseases from outside and a systematic method of controlling the disease within. The system should be designed in consultation with the Veterinary Surgeon. The Veterinary Surgeon is not only to treat the sick animals but to look after the farm management, general hygiene, prevention and vaccination etc. in the farm. The fresh stock should be purchased from a known clean source. Prior to mixing with the healthy stock, it should be housed separately for 3 weeks. Transport vehicles should be parked away from the pig accommodation. These type of precautions may limit the movement of infections.

27.1 Emerging Pig Diseases

27.1.1. Bacterial Diseases

The disease conditions responsible for heavy losses in swine are pneumonia, enteritis and pneumoenteritis. These conditions may be associated with bacteria, virus, chlamydia, mycoplasma and parasites.

Anthrax

This is a highly infectious bacterial disease of warm blooded animals. The causative organism of this disease is *Bacillus anthracis*. Man can acquire the disease from infected carcasses or by-products by handling, inhaling contaminated air, or eating infected meat. Anthrax can often be detected by proper antemortem inspection. Once the infected carcass has been removed unnoticed from the abattoir, the disease can spread rapidly. The anthrax bacillus forms resistant bacterial spores which can remain viable in the soil and elsewhere for very long periods. Care should be taken to remove a suspected carcass from the abattoir floor. The contaminated premises should be disinfected with a 2 % caustic soda solution. Carcasses infected with anthrax should be destroyed completely, if possible by

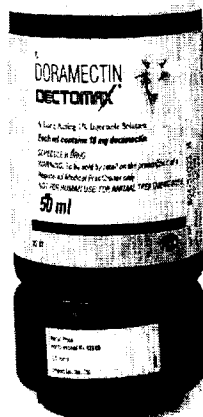
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burning. If buried, the pit should be sufficiently deep to prevent the carcass being dug up by dogs. Lime sprinkled on the carcass before burial also reduce the danger of the disease spreading.

Pneumonia

It is not a disease but clinical manifestation of the disease. It is more commonly found in young piglets particularly during the first four months of life. Possible sequence of infection in upper respiratory tract may be complex. It may be caused by bacteria, chlamydia, mycoplasma or viruses alone or in combinations. The disease condition is sudden in onset and usually whole litters are affected. There is rise of body temperature (104-107°F) and cessation of suckling. Other clinical manifestations may be coughing, respiratory distress and occasionally nervous disorders and lameness.

Treatment of bacterial pneumonia depends upon the causal factor such as *Pasteurella*, *Salmonella* or *Mycoplasma*. In case of pneumonia caused by *Pasteurella* organisms, sulfonamides 33.3% solution at the dose rate of 200 mg per kg body weight given intraperitoneally or subcutaneously gives good results. The treatment should be continued for 5-6 days. Broad spectrum antibiotics such as oxytetracycline or chlortetracycline at the dose rate of 10 mg per kg body weight given I/v or I/m is also quite effective.

If the cause is *Salmonella* organisms, the best treatment would be using chloramphenicol at the dose rate of 10-20 mg per kg body weight given I/m or I/v. When *Mycoplasma* is suspected to be the cause of pneumonia, then Tylosin at the dose rate of 2-10 mg per kg body weight gives good results.

Supportive treatment includes cleanliness, proper ventilation and provision of oxygen. The affected animals should be housed in warm rooms. There should be provision for fresh water, light and nourishing food. Exposure to inclement weather should be avoided. Forced oral feeding may also be avoided. If it is a herd problem, affected pigs should be isolated and antiseptic inhalations may be used.

Enteritis

It is also one of the clinical manifestations of the diseases caused by bacteria, parasites and/or viruses. The change of diet, chill and un-hygienic conditions are some of the predisposing factors for this condition. It is characterized by diarrhoea, dehydration and death. This condition may be treated with appropriate antibiotics along with symptomatic treatment as under:

E. coli is the main cause of infection. In such cases Furazolidone at the dose rate of 5-10 mg per kg body weight gives good results. Sulfonamides such as sulfaguanidine and sulphathalamide or sulfonamides in combination with streptomycin are quite effective. Sulfonamides can be given at the dose rate of 200 mg per kg body weight and streptomycin at 5-10 mg per kg body weight for 4-5 days. Chloramphenicol and tetracycline can also be used. If the cause of enteritis is due to salmonella organisms, then chloramphenicol is the drug of choice. Iron deficiency should be corrected by giving injections of iron. Dehydration should be corrected by giving fluid therapy.

Control: Food consumption should be reduced. Antibacterial drugs such as neomycin, tetracycline, streptomycin and nitrofurazone can be used in drinking water

Colibacillosis

The causal organisms for this condition are *Escherichia coli*. Piglets may become ill within 12 hours of birth and die of acute toxemia or septicemia within 48 hours and often without diarrhoea. Diarrhoea appears shortly after appearance of lethargy in piglets surviving the first two days. The hair coat becomes rough. The animals become dehydrated and emaciated. There is discoloration of perineal area and tail due to coating of faeces. On necropsy, milk clots are seen in the stomach. This disease may be kept under control by adopting strict hygienic measures and sick animals may be treated with antibiotics along with supportive therapy as mentioned earlier.

Salmonellosis

The causative agent of this disease is *salmonella* sp. It is a disease of cattle, swine and poultry. It is transmitted via ingestion of under-cooked meat contaminated with feces. Salmonella bacteria cause mainly gastro-intestinal infections. Meat borne infections are very common through contamination of meat from infected animals during slaughter.

The important salmonellae involved are *Salmonella typhimurium* and *Salmonella cholerae suis*. Mortality in clinically affected pigs is very high though morbidity is low. It is more common in young piglets than the adult ones. In acute form, it is characterized by dullness, depression, rise of body temperature, prostration and death. Diarrhoea, dysentery, meningitis and encephalitis have also been seen. On post-mortem examination, the disease is characterized by catarrhal gastroenteritis.

Treatment:

Streptomycin or streptomycin in combination with neomycin at the dose rate of 10 mg per kg body weight given orally are very effective, Furazolidone in 5-10 mg per kg body weight given orally gives satisfactory results. The treatment may be repeated for 3-5 days. Bifuran containing 25% nitrofurazone and 3.6% furazolidone is valuable in Salmonella infection. It can be mixed in feed in recommended doses for 5-7 days for all pigs. Neomycin and chloramphenicol at 10-20 mg per kg body weight have been used as drug of choice. These compounds can be added in feed if the animal is still eating otherwise it may be given in drinking water. Sulfonamides such as sulphaguanidine and sulphathalamide have been widely used. Sulphamezathine both by mouth and by injection had been found to be very effective in controlling the outbreaks due to salmonellosis.

Control:

1. Proper attention towards sanitation.
2. Strict quarantine measures for newly purchased pigs for at least 3 weeks.

3. Advance cases of diseases may be slaughtered.
4. Vaccination is very effective for control.
5. Provide clean, warm dry housing and also provide balanced ration containing nicotinic acid.
6. Place pigs on concrete floors which are disinfected daily.

Pasteurellosis

The causal organism is *Pasteurella multocida*. The affected pigs show the clinical signs of bronchopneumonia. Initially coughing and dyspnea are noted. In severe cases, there is rise of body temperature (105-106°F), nasal discharge, anorexia, depression, weakness, prostration and death within 5-10 days. The affected pigs may successfully be treated with antibiotics notably penicillin, streptomycin or tetracycline as well as sulfa drugs like sulfamethazine, sulfamerazine or sulfathiazole in recommended doses.

Tuberculosis

Tuberculosis in pigs may be caused due to *Mycobacterium tuberculosis*, *M. bovis* and *M. avium*. It is mainly acquired by feeding of garbage and human excreta. In generalized form, it is characterized by rise in body temperature, anorexia, loss of weight, dysphagia, dyspnea and coughing. Granulomatous lesions may be present in any part of the body such as lymph glands, liver, lungs, spleen, joints and other organs. It is transmitted through handling of contaminated meat. It causes gastro-intestinal infections as well as lung infections. Meat borne infections can occur from the contamination of meat by tuberculosis infected butchers and handlers and by contact with meat derived from infected animals during slaughter. Careful antemortem and post-mortem inspection with particular reference to the lymph glands, is essential to reduce the danger of the contamination. Treatment is not practical and disease may be contained by regular testing and segregation method.

Brucellosis

The disease is caused primarily by *Brucella suis*. It is characterized by abortions, stillbirths, infertility, unilateral or bilateral orchitis, posterior paralysis and lameness. Decreased

sexual desire is occasionally observed in the affected boars. There is no effective treatment, however, the disease may be kept under control by regular testing and segregation of the affected pigs.

27.1.2. Viral Diseases

Swine fever or Hog Cholera

It is a highly infectious septicemia caused by a virus and characterized by the generalized hemorrhages, 95-100% morbidity and almost as high mortality. This infection usually runs an acute course but may become chronic. Lesions may be very mild or absent in peracute cases but severe to extreme in acute and subacute infections. Complications may arise due to the secondary bacterial infections, particularly with *Salmonella cholerae suis* or *Pasteurella multocida*.

The chief clinical signs noted in the affected pigs are dull, loss of appetite, high rise of temperature, constipation convulsion, staggering gait, conjunctivitis and bleeding from nose and rectum. Red or purplish blotches on the skin of the ears, belly and inner surface of legs may be present. Diarrhoea and pneumonia may also be present. There is no effective treatment for this infection. However, the disease may be kept under control by adopting hygienic measures and vaccinating the stock with swine fever lapinized vaccine (Attenuated).

Comments of National Commission on Agriculture (1976)

"35.5.57 Swine fever was not recorded in India till 1960. There is a view that the disease got introduced in the country with pigs imported during 1961-62. For several succeeding years the disease caused heavy mortality among pigs. In 1967, about 5000 pigs died of swine fever in the Car Nicobar Island alone. However, as a result of large scale vaccination with crystal violet inactivated vaccine and lapinised virus vaccine the disease has been brought under control".

"35.5.61 As swine fever is almost wholly under control, quarantine regulations should be rigidly followed in the case of all pigs imported from abroad. It will also be worthwhile to investigate if wild pigs or some other non-swine reservoirs of this infection exist so that appropriate action may be taken for the elimination of the swine fever virus and for checking its spread to the domestic pigs".

Swine influenza

It is an acute infectious respiratory disease of swine caused by a type A influenza virus. It is sudden in onset and is characterized by conjunctivitis, lacrimation, coughing, dyspnea, fever (105-108°F), prostration and rapid recovery. Morbidity is high but mortality is low. Lesions develop rapidly in the respiratory system and regress quickly except in a few complicated cases when a severe bronchopneumonia may be followed by death. Secondary bacterial invaders may complicate the disease condition and these organisms include *Salmonella typhimurium*, *Pasteurella multocida* and *B. haemolytic E. coli*. The affected animals may be given symptomatic treatment along with antibiotic to check secondary bacterial infections.

Swine Pox

It is a highly contagious disease caused by two antigenically distinct pox viruses i.e. Vaccinia virus and Swine Pox virus. The disease caused by these two viruses is indistinguishable under natural conditions. The pox is found to be transmitted through ticks, *Hyalomma anatolicum* and usually pigs between 2-4 months of age contract the disease. The affected pigs show restlessness, anorexia and slight rise of body temperature. Characteristic pock lesions are seen on the surface of the ears, face, neck, inner side of the legs and on the belly. At times ulcers in the digestive tract and pneumonia may be seen. Herd morbidity rate is high but mortality rate is almost negligible. The affected pigs may be given symptomatic treatment along with antibiotics for secondary bacterial infections.

Foot and Mouth Disease

It is highly contagious disease caused by *Picornia* viruses. The affected animals have an elevated temperature and are reluctant to stand and walk. The clinical signs include vesicles and erosions on the snout, lips and tongue, on the coronary band and between the claws on the feet. Morbidity is high but mortality is low except in young animals. In piglets, mortality is due to the involvement of heart muscles causing

myocarditis. The disease may be kept under control by adopting strict hygienic measures and treatment of the foot lesions with 1% copper sulphate or phenyl lotion and mouth with 2% alum or potassium permanganate lotion.

27.1.3. Parasitic Diseases

27.1.3.1 Internal Parasites

Gastrointestinal Parasites of Pigs

Stomach Worm infestations

These worms are commonly found in grazing pigs. Three types of stomach worm occur in pigs, viz. *Hyoststrongylus rubidus* (red stomach thin worm), *Ascarops strongylina* and *Physocephalus sexalatus* (thick stomach worm of 12 mm or more in length).

Clinical signs

Reduced host condition with variable appetite, anaemia, diarrhoea and loss of weight are the common signs of stomach worm infestations.

Diagnosis

Faecal examination may show the distinctive ova of *Physocephalus* and *Ascarops*, small thick-shelled eggs containing an active larva. At Post-mortem examination, adult worms, especially *Physocephalus* and *Ascarops* are readily seen.

Treatment

Thiabendazole, levamisole and dichlorvos are effective against *Hyoststrongylus*. The benzimidazoles, pro-benzimidazoles and ivermectin are highly effective and also will remove related species. carbon disulfide is recommended against *Physocephalus* and *Ascarops*.

Round worm infection

i) *Ascaris suum*

This species is cosmopolitan in distribution, occurring in the pigs. For many years this species was considered synonymous with the human parasite *A. lumbricoides*, however, there is now an evidence that these are distinct species.

A. suum is a large worm and a serious pathogen in swine. The adults live in the lumen of the small intestine, where

they compete with their host for food and markedly decrease feed efficiency. The adults are found principally in the small intestine, but they may migrate into the stomach or bile passages. They are 30 cm or more in length and quite thick. Large numbers of eggs are produced, as many as 2,50000/day. The eggs develop to the infective stage in 2-3 weeks and are very resistant to chemical agents. When the eggs are ingested, the larvae hatch in the intestine, penetrate the intestinal wall and enter the portal circulation. After a period of growth they are carried by the circulation to the lungs. About 9-10 days of digestion, the larvae leave the lungs by passing up the bronchial tree and mature in small intestine. The first eggs are passed 2-2.5 months after infection.

Clinical findings

The affected pigs become stunted, unthrifty and weak. They loose flesh and have a rough coat. Sometimes diarrhoea may develop. However, the effects of the larvae are even greater than those of the adults. The larvae migrate through the liver parenchyma and cause white spots and fibrosis. In the lungs, they cause verminous pneumonia, with an asthmatic cough "thumps", difficult breathing, oedema, hemorrhagic foci and emphysema. Affected animals may die. Ascarids also exacerbate virus pneumonia.

Newly born pigs which become heavily infected, may show signs of pneumonia, especially a cough and exudate into the lungs. Larvae may be found in the sputum. Ascaris eggs are found in the faeces of older pigs or in the soil on which the animals are kept.

Treatment

Sodium fluoride removes 90 per cent of mature and immature ascarids and it has been widely used. It must not be given with a wet feed because it may then be toxic; nor should it be given with whole grain. It mixes well only with ground grain, wheat meal or oat meal. It is not very palatable and is best given in the morning after starvation for 24 hours. It should not be given to pigs in poor condition. It can be given to

pregnant sows. Satisfactory results are obtained when sodium fluoride is mixed with dry feed at the rate of 0.1-0.15 g per lb. body weight.

Another method is to mix sodium fluoride as 1 per cent of the whole day's feed and to give this day's feed in three parts, in the morning, at mid-day and in the evening. This dose may be repeated, if necessary, after 4 weeks to remove parasites which have matured since the first treatment.

Piperazine compounds: These are usually administered in the food, 100-300 or 400 mg per kg body weight giving excellent results.

Thiabendazole: A mixture of 0.1-0.4 per cent in the feed has been reported to eliminate adult worms and also to have an effect on migrating larvae.

Prophylaxis: The eggs survive best in damp, dirty and overcrowded quarters so that cleanliness and good management are important. The animals should be removed to a temporary enclosure for treatment and transferred to fresh ground within 10 days, before any eggs passed by them become infective. Sites with concrete floors can be kept clean by scrubbing out with boiling water and soda every 10 days or longer, depending on the temperature.

The McLean County system of swine sanitation:

It not only prevents ascarid infections but many infectious diseases as well. It comprises four measures:

- (a) Cleaning the farrowing quarters before putting the sows in them. Scrub pen with a hand broom and plenty of boiling lye (a highly concentrated aqueous solution of potassium hydroxide or sodium hydroxide) water containing 1 lb. of lye per 20 gallons of water. Finally clean the quarters with high pressure steam or boiling lye water. Give final rinse with clear, hot water. Wash sows with a scrub brush, before putting them in the farrowing pens. This removes eggs that may be adhering to their bodies.
- (b) Haul the pigs and sows to pasture when the time comes. Do not drive them down contaminated lawns.

- (c) Keep the pigs on clean pastures which have not been used by pigs for several years.
- (d) Do not track worm eggs into farrowing pens on dirty shoes.

ii) *Metastrongylus*

They live in the bronchi and bronchioles of swine. Three species are commonly found, *M. apri*, *M. pudendotectus* and *M. salmi*. They look much alike and mixed infections are the rule. Their life cycle is indirect. Infective larvae develop in earthworms. Lungworms are the causal agent of verminous bronchopneumonia in pigs. This infection is characterized by respiratory discomfort, cough and nasal discharge.

Treatment and control

Levamisole 8 mg/kg given in the water or levamisole resinate, given as 0.08% levamisole hydrochloride equivalent, in the feed has high efficiency in pigs and has broad spectrum activity against other parasites of the pigs. Mebendazole when given at 15 mg/kg body weight on two successive days shows activity but when given in pelleted feed no effect is noted.

Control measures include avoidance of the intermediate hosts. Little can be done to control earthworm populations, and pigs which run in dirty yards or at pasture, should be moved at short intervals to prevent ingestion of infested worms. Pastures which are known to be contaminated should be left for at least 6 months before restocking, although infected earthworms may persist in hog lots up to 4 years.

Trichinella spiralis

By far the most important parasite associated with pig muscles is *Trichinella spiralis*. *Trichinella spiralis* is unusual in that the same individual animals both its definite and intermediate host. The adults are found in the small intestine and the encysted larvae in the muscles. Most human infections come from eating uncooked or insufficiently cooked pork. Pigs acquire their infections mostly by eating uncooked garbage, from other pigs or rats. The latter generally become infected from pigs. The parasite is of principal importance in human

medicine and it is unusual for any obvious clinical entity to be associated with the infection in domestic animals. The diagnosis of *T. spiralis* infection in animals depends mainly on the detection of the infection at meat inspection.

Treatment

Thiabendazole has been demonstrated to be effective against both the adult intestinal phase and the larval muscle phase. It has also been used successfully in human infection.

Trichuris infection

Trichuris suis is 5-8 cm long and consists of a slender anterior portion and thickened posterior third. The infection is by ingestion of embryonated ova. Inflammatory lesion in the cecum and adjacent large intestine are due to heavy infections. Clinical signs includes diarrhea and unthriftiness. The double-operculated eggs are demonstrated in faeces. Dichlorvos and levamisole are very effective against this worm.

Flatworm infection

Fasciola hepatica (liver flukes) may be found in the bile ducts of pigs in endemic areas. The fluke is cosmopolitan in distribution and is the cause of fascioliasis or liver fluke disease (liver rot). *Fasciola gigantica* replaces *F. hepatica* in the tropics and subtropics, such as Africa, southern Asia, the southern United States and Hawaii. Its principal intermediate host is *Lymnaea auricularia*, which prefers a warmer climate than *L. truncatula* and is also a more aquatic snail.

Liver fluke infestation is common among pigs having access to areas of low lying pastures and stagnant water containing fresh water snails. This infection produces anaemia, emaciation and digestive disturbances in pigs. In swine treatment for this infection is subcutaneous injection of carbon tetrachloride mixed with liquid paraffin.

Cysticercosis

This is particular health hazard to man because infected cattle, buffalo and pig muscle contain the cysts, and intermediate or developmental stage of *Taenia hydatigena* (*T. Marginata*), one of the large tapeworms of man. It may reach to the length of

over 16 feet. Its cystic stage, *Cysticercus tenuicollis*, occur in the viscera of various animals, especially sheep, cattle and pigs.

Hydatidosis

Hydatidosis is the infestation of the hydatid cysts produced in various parts of the body by the growth of the immature forms of tape worms. The causative tape worm is known as *Echinococcus granulosus*. It consists of only 3 or 4 segments, and measures under an inch long. Its larval stage is the hydatid found in all the domestic animals, but most commonly in sheep, cattle and pigs.

The principal hosts are dogs, wild carnivores, sheep and cattle. The dog is the most important link in the biological cycle of this tapeworm. These cysts in man are much more fertile than those found in cattle, pig and buffalo. In man these cysts may even locate themselves in the brain.

27.1.3.2 External Parasites

i) Sarcoptic mange

It is a chronic skin condition caused by *Sarcoptes scabiei* var. *suis*. It is characterized by itching and rubbing leading to thickened and wrinkled skin. There is loss of hair and abrasions on the skin. Skin papules may be seen on the rump, flank and abdomen.

Treatment

It includes insecticidal treatment in the forms of spray, dip and dust containing active principles of insecticides to treat external parasites.

ii) Lice

Pig lice, *Haematopinus suis* effect the pigs. The affected pigs show restlessness, itching and rubbing. The heavy infestation may result to anaemia and consistent irritation interferes with growth rate and food conversion. Lice are destroyed by the treatments used for sarcoptic mites.

iii) Fleas

These are not host specific and this infestation disturbs the pigs seriously. Besides, it can also transmit infectious diseases such as swine pox.

iv) Demodex

Demodex phylloides causes caseous nodules in hair follicles and sebaceous glands. Secondary staphylococcal infection may occur. The mite is irritating but it apparently does little damage except to the leather.

The guidelines for insecticidal treatment of external parasites is given in Table 27.1.3.2.1.

Table 27.1.3.2.1 Guidelines for Insecticidal Treatment of External Parasites

Active Chemical	Concentration	Parasites affected	Direction for use	Slaughter with-holding time
Malathion	0.5% emulsion	Lice, ticks	Spray	Nil
	5% dust	Fleas, lice	Dust thoroughly	
	2.5% emulsion	House flies and fleas	Spray houses and premises	
Rotenone	1% powder	Fleas	Dust heads, necks and backs	Nil
Toxaphene	0.5% emulsion	Lice, mites	Spray thoroughly	28 days
Trichophanon (Neguvon)	0.125% emulsion	Lice, mites	Spray thoroughly	Nil
Lindane	0.06% emulsion	Lice, mites	Dip or spray	60 days (dip)
	1% dust	Fleas	Dust head, necks and backs	30 days (spray)
Ciodnin	0.25%	Lice	Sprays, pigs, pens and surrounding Repeat 7-10 days	Nil
Diazinon	0.05% emulsion	Lice, mites	Spray pigs 3 times at 10 days interval	14 days

27.1.4 Nutritional Deficiency Diseases

Pigs are also affected by nutritional deficiencies and show

scour, stunted growth and poor feed conversion efficiency. The important deficiency diseases in pigs have been mentioned as under:

27.1.4.1 Protein Deficiency

A very few feed ingredients provide the essential amino-acids required by the pigs. Therefore, the diet should be formulated in such a way that it meets the amino acid requirements. Clinical signs of protein/ amino-acid deficiency include poor growth, rough hair coat and impaired lactation. Lysine is very important for pig growth. The synthetic lysine supplement can be used for supplementing the diet.

27.1.4.2 Vitamins Deficiency

Vitamins are required in multiple amounts but its deficiency can be overcome by addition of vitamin supplements in the diet of pigs. Deficiency of vitamin-A during gestation results in multiple birth defects. Vitamin-D deficiency results in impaired calcium absorption which causes rickets in growing pigs. Riboflavin deficiency causes dermatitis.

27.1.4.3 Minerals Deficiency

All minerals should be balanced and supplemented in the diets. Salt is toxic to swine which is characterized by depressed growth seizures and paralysis. Phosphorus deficiency causes significant reduction in daily gain.

Iron deficiency causes Piglet anaemia in suckling pigs. Supplemental iron can be administered by swabbing the sow's udders with iron sulphate or by oral supplementation. After weaning, iron should be provided in diet.

Iodine deficiency is also prevalent in new born piglets. The piglets are hairless having thickened skin. These are weak and die shortly after birth. Potassium iodide in suitable amounts may be added to the normal diet of the sows.

27.2 General Measures for Disease Control

- ☐ Provide clean, warm and dry housing for different ages of pigs.
- ☐ Place pigs on concrete floors which are disinfected daily.
- ☐ Strict quarantine measures for newly purchased pigs for at

least 3 weeks before they are allowed to mix with the old stock. During the isolation period all animals should be examined against parasitic diseases and other bacterial diseases.

- ☐ Give proper attention towards sanitation and hygiene. Regular cleaning of the shed, maintenance of hygiene and sanitation, proper disposal of sewage materials from the farm should be the routine practices.
- ☐ Antibacterial drugs such as neomycin, tetracycline, streptomycin and nitrofurazone can be used in drinking water or feed to control infection.
- ☐ Proper vaccination schedule should be followed. Pigs are required for vaccination against swine fever in between 6-8 weeks.
- ☐ Movement of stray animals in the farm area should be prohibited. Visitors should be allowed only after proper dipping of their shoes in a strong solution of strong antiseptic or disinfectant. Visitors should not be allowed at least during an outbreak of the disease.
- ☐ Adopt regular deworming of pigs. Deworming of piglets on 21st day and follow up action at 2 months interval is highly effective against worms.
- ☐ Infeon injection should be given to each piglet during the first and third week to prevent from piglet anaemia.
- ☐ The nutritional deficiency diseases can be prevented by addition of vitamin and mineral mixture in the feed.

27.3 Zoonotic Diseases

27.3.1 ZOONOSES

The zoonoses may be defined as those diseases of animals that are transmitted to man. The major concept of meat hygiene and inspection relates to the fundamental principle that the meat reaching the market is sufficiently well examined before and after slaughter, as well as during the process of cutting, handling and retailing to ensure the freedom from diseases which can be transmitted to man.

In India, rigid criteria of inspection is not practiced and

can not be applied to the local marketing. However, care is being taken by local authorities to protect the consumer and abattoir worker from exposure to infection.

27.3.2 Zoonotic Diseases of Pigs

Zoonotic diseases are the diseases, which are communicable between animals and man. The zoonotic diseases which are communicable through pigs are given in Table 27.3.2.1.

Table 27.3.2.1 Zoonotic Diseases of Pigs

Name of disease	Causative organism	Means of spread to Man
Anthrax	Bacillus anthracis	Human infection is through skin, spores inhaled or ingested
Brucellosis	Brucella suis	Direct contact with secretions or excretions of infected pigs
Salmonellosis	Salmonella spp.	Ingestion of undercooked food contaminated with feces.
Tuberculosis	Mycobacterium tuberculosis	Ingestion, inhalation and exposure to infected pigs .
Pork tapeworm, Cysticercosis	Taenia solium	Ingestion of "measly" pork, autoinfection
Trichinosis	Trichinella spiralis	Ingestion of uncooked infected pork.
Foot and mouth disease	Rhinovirus Types A.O.C, SAT and Asia	Contact exposure with infected pig.
Japanese B encephalitis	Flavivirus/ Group B	Mosquitoes- culex spp, Aedes
Vesicular stomatitis	Vesicular stomatitis virus	Through inhalation

27.4 Vaccination-A Tool for Pig Health

In modern pig production vaccination is an important tool in health management. Its successful use has meant that diseases that once scourged pig farms are now a part of history. In more recent times vaccines have been used to minimize the economic impact of debilitating diseases on a herd's reproductive and/or commercial performance. However, there is a myth that vaccines are wonder products that cure everything. That is not the case!

For vaccination to work the right vaccine(s) must be given in the right way to the right pigs at the correct time. Thus, a major part of successful vaccination, and a part that is often overlooked, is the management of the people doing the vaccination. First and foremost never vaccinate for the sake of vaccination. Discuss your herd's situation with your veterinarian on a regular basis to ensure that you are always using the right products. Vaccination in this context will have two goals:-

- ☐ to protect your pigs from disease already on your farm and
- ☐ to protect them from diseases that could come on to your farm.

For the second of these you may well have to do some kind of risk analysis. For example there may be little sense in spending huge amount on a vaccination programme for a disease that is highly unlikely to get on to your farm.

27.4.1 Points for Successful Vaccination

Successful vaccination is very dependent on getting the right dose into the right place in the right pigs. This may appear very obvious and even simplistic but it is surprising how often this triple goal is not achieved. How often have you checked your vaccinating equipment to confirm that it really is administering the dose it should be? This can be done by measuring the dose that is given or by just counting the number of doses given by one bottle. If the dose is 1.0 ml and a 100 ml bottle of vaccine provides 99 or 102 doses all is well. If, on the other hand, you are able to vaccinate 150 pigs something is wrong as you are only giving each pig two thirds of its dose. Getting the dose in the right place involves following the

manufacturer's instructions and then checking that key instructions such as the size and length of needle used are correct. You may smile when we talk about the 'right' pigs but quite often one pen or group of pigs is vaccinated twice in error, while a neighboring pen or group is missed. Here again we must focus on people and systems management. Do you have a foolproof way to tell you which pigs have been vaccinated and when they received their last dose? If the fridge is running at too low a temperature it may, in effect, be a freezer. Freezing can damage some vaccines. On the other hand, if the temperature is running too high, for example over 10°C, it is effectively an incubator and, as such, is not providing the preferred storage temperature. Here again long term storage at an elevated temperature can reduce the potency of some vaccines. Vaccines can be easily contaminated. Dirt which contains bacteria can be introduced to the vaccine bottle via a dirty needle or by inserting a clean one through a dirty or wet vaccine bottle top. This will introduce bacteria into the vaccine. If the vaccine is then stored at an elevated temperature these bacteria will multiply to large numbers. If the contaminated vaccine is injected into pigs, the bacteria that was inadvertently introduced may be capable of causing abscesses and even generalized septicemia in the vaccinated pigs. For example one occasionally sees an outbreak of erysipelas in boars in the breeding herd and on investigation one finds that the instructions were given to vaccinate each sow at weaning and that the staff did not vaccinate the boars because they did not have litters weaned off them. So, here is an example where clear and precise instructions are paramount. Do you have a central recording system that senior management can quickly glance at to check that this week's vaccinations have been done? When it comes to the vaccine itself it can lose some of its potency by being incorrectly stored before use or being kept beyond its expiry date. Again, these are two very basic points but if they are not adhered to they can take the edge off the effectiveness of your vaccination programme. Most pig vaccines should be stored in a refrigerator at 2-6°C. This will

produce losses due to mortality and/or condemnation because of abscesses. At the end of the day your vaccination programme has worked for you if it protects your pigs against the diseases it is designed to protect them against. For most pig vaccines this is said to have occurred if the diseases are not seen. This can be a dangerous assumption to make as the reason for not seeing the disease could be that the disease never came to your farm. Thus, you could easily be lulled into a false sense of security. In the poultry sector flocks are bled after vaccination and the level of vaccinal antibodies in the blood are then measured as an indication of the level of immunity in the herd. This type of information is the ultimate check on a vaccination programme.

27.4.2 The Key Factors of Vaccination

In vaccination the pig is provided with appropriate antigens, which stimulate the pig's immune system to produce antibodies for protection. Following are the key aspects of vaccination:-

1. Choice of Vaccine

Use the vaccine for the disease protection that is needed against. If several options are available choose the most effective product.

2. Correct Vaccine Storage

Before buying, ensure the expiry date and also ensure vaccine are correctly stored at 2-8°C.

3. Vaccination Programme

To achieve proper protection, more than one vaccination may be needed. Make sure that all the vaccinations are given at correct time.

4. Correct Pigs

Correct age and health of the pigs are important for success of vaccination.

5. Correct Dose of Vaccine

Correct dose of vaccine is important for full protection against disease.

6. Vaccination Technique

The vaccine must be carefully and correctly administered to all pigs.

27.5 Pig Vaccines-Novel Strategies for Future

In India, there are main two viral diseases for which vaccine is available for safe control.

27.5.1 Swine fever Vaccine

Swine Fever vaccine is being manufactured by many firms like Hoechst Russel Vet., Indian Veterinary Research Institute, Izatnagar and other State Biological Products institutes, and is available in the country. Please follow the instructions of the manufacturer. The general information on swine fever vaccine is as follows:-

Type of Vaccine

Several vaccines have been used to protect pigs against Swine fever virus infection. At the early state inactivated vaccines, being safe and innocuous obtained by exposure of viral antigen to the activity of some chemicals such as formalin or crystal violet have been used.

(a) Inactivated Viral Vaccine

The crystal violet inactivated vaccine against swine fever is safe to use and does not produce clinical disease. However, the inactivated vaccines are only able to prevent the clinical manifestations of the disease but not to avoid the possibility of foetal infection in vaccinated sows when exposed to virulent virus. The immunity produced is not so strong and durable as that induced by live attenuated vaccine. It is generally suitable in areas where the danger of introducing the disease is not great.

Dose

Two doses of 5-10 ml vaccines are administered subcutaneously two weeks apart.

Immunity

Immunity develops in 2-3 weeks and lasts for about 8-12 months.

(b) Tissue Culture Live attenuated Freeze Dried

It is a tissue culture live attenuated freeze dried swine fever vaccine for active immunization against "Swine fever disease".

Dose

1 ml of reconstituted vaccine for all category of pigs

irrespective of age, breed and sex.

Storage

The vaccine can be stored in freezing chamber of the refrigerator for a short period and for long period it can be stored at -15 to -20° C in deep freezer.

Immunity

The vaccine is expected to last immunity for about one year.

(c) Swine fever Lapinised Vaccine (Living)

It is prepared from spleen of infected rabbits and it is freeze dried vaccine.

Age of vaccination

Piglets above 3 months of age can be vaccinated.

Dose

1 ml of reconstituted vaccine intramuscular for all age group of pigs per year.

Presentation and Storage

The vaccine is available in pack of 5/10/25 doses and can be stored in freezer chamber of the domestic refrigerator for 3 months. For longer shelf life, i.e. 6 months, it should be stored at -20° C in freezer.

reconstituted vaccine should be stored on ice and used within 2 hours of reconstitution.

Transportation

The vaccine should be transported in thermos-flasks on ice and can also be supplied by air.

27.5.2 Foot and Mouth Disease Vaccine

Foot and Mouth Disease from Hoechst Roussel Vet

“*Clovex*” is an oil adjuvant, BEI inactivated Foot and Mouth disease vaccine which gives protective immunity up to 12 months under the recommended vaccination schedule. It is available as Monovalent, Biovalent, Trivalent and Tetravalent. It is recommended for disease control by routine vaccination in endemic areas, it can also be effectively used to prevent the spread of disease during the outbreaks.

Age of Vaccination

Young piglets

Primary vaccination is done at the age of 3 weeks onwards in piglets. First booster vaccination is done after 3 to 3.5 months of primary vaccination and second booster vaccination is done after 6 months of first Booster. Re-vaccination is done approximately 12 months after 2nd Booster vaccination.

Adult pigs

Primary vaccination is done at any stage of life including pregnancy. First booster dose is given after 6 months of primary vaccination, and second booster dose is given 3-4 after the first booster vaccination, followed by biannual (6 monthly) boosters is recommended in highly endemic zones. In other areas re-vaccination can be done approximately every 12 months after booster vaccination.

Dosage

In pigs Monovalent and Bivalent vaccine is administered in doses of 1 ml intramuscular, Trivalent in dose of 2 ml intramuscular, and Tetravalent in dose of 3 ml intramuscular.

Presentation and Storage

For pigs vial of 30 ml and 90 ml is available and can be stored at +2° to +8°C in dark area.

27.6 General Drugs used in Treatment of Pigs

27.6.1 Antiseptics

Antiseptics are those chemical agents which prevent disease by hindering or disallowing the growth of micro-organisms, without necessarily killing them. Disinfectants or germicides, kills the micro-organisms. Many substances may be classified as either antiseptic or disinfectant according to the strength used. Strong antiseptic or disinfectant cause destruction of cells, and should not be used in wounds. Commonly used antiseptics at pig farms is as follows:-

Acriflavine

It is one of the best antiseptic for a healing wound. It is non-irritant to cells but kills the micro-organisms. It is used as a solution of 1 part in 1000 parts of water.

Dettol

Dettol or Liquor Chloroxylenolis is a powerful bactericides of low toxicity. It is used for skin cleansing, obstetrical work and disinfecting premises.

Table 27.6.3.1 Deworming Schedule for Pigs

Type of worm	Age & interval	Name of deworming agent	Dose and route
1. Round worms <i>Ascaris suum</i> <i>A. lumbricoides</i>	First dose at 3 weeks and repet at 21 days and follow up action at 2 months interval	(i) Albendazole (2.5%))	5 ml /25 kg body wt orally
		(ii) Cestophene (Dichlorphen)	0.2 gm/kg body wt orally
		(iii) Panacur (2.5%) (Fenbendazole)	5 mg/kg body wt orally
		(iv) Piperazine salts	100-300 mg/kg body wt.
		(v) Thiabendazole	0.1-0.4% in feed
2. Lung worms (Metastrongylus) <i>M. apri</i> , <i>M. pudendotectus</i> and <i>M. salmi</i>	First dose at 3 weeks and repet at 21 days and follow up action at 2 months interval	Levamisole	8 mg/kg body wt. in feed
		Mebendazole	15 mg/kg body wt
		Dichlorvos	5 mg/kg body wit
3. Whipsorms			
4. <i>Trichinella spiralis</i>		Thiabendazole	0.1 to 0.4% in feed
5. Flatworm (<i>Fasciola hepatica</i>)		Carbon Tetrachloride with liquid parafin	1 to 1.5 ml orally

Savlon

It is a very powerful antiseptic with no irritating effect and is used in dressing of wounds and bathing of sick pigs.

Alcohol

It is a very powerful antiseptic chiefly used for removing grease and septic matter from the hands of the surgeon and the skin of the pigs.

27.6.2 Antibiotics

In modern pig production, antibiotics are fed to pigs as growth promoters. The main antibiotics used in pig feed includes Zinc bacitracin and Flavomycin.

27.6.3 Anthelmintic Compounds

The anthelmintic compounds used in pigs for deworming of pigs are presented in Table 27.6.3.1.

27.6.4 Vitamins and Other Supplements

The vitamins and mineral supplements are used for meeting requirements of vitamins and minerals and the quantity is used as per the manufacturer's instructions in feed and water. In addition to these, there is need to supplement amino acid requirements in form of DL-Methionine in feed. The quantity of DL-methionine would depend upon the composition of diet and availability of amino acid in the feed.

27.7 Reduction in Piglet Mortality

Piglet mortality is one of the main source of economic loss to the pig farming. From the movement the piglet leaves the warm security of womb and enters the birth canal, it becomes exposed to an infected environment. Under natural conditions it is protected against this environment by the wide range of antibodies received from its mother in the first milk, the colostrum. The piglets always die deprived of colostrum. It is essential to observe that every piglet gets sufficient amount of colostrum.

27.8 OIE Classification of Pig Diseases

The International Animal Disease Reporting System is done by the OIE (Office International Des Epizootics, with a view to minimize the spread of important diseases and in achieving better worldwide control of these diseases and to increase international

trade of livestock products. The classification of the important diseases of pigs is as follows:-

27.8.1 LIST A DISEASES

Transmissible diseases which have the potential for very serious and rapid spread, irrespective of national borders, which are of serious socio-economic or public health consequence and which are of major importance in the international trade of animals and animal products. Reports are submitted to the OIE as often as necessary to comply with Articles 1.2.0.2 and 1.2.0.3 of the *International Animal Health Code*.

Foot and mouth disease

Vesicular stomatitis

Swine vesicular disease

Rinderpest

African swine Fever

Classical swine fever

27.8.2 LIST B DISEASES

Transmissible diseases which are considered to be of socio-economic and/or public health importance within countries and which are significant in the international trade of animals and animal products. Reports are normally submitted once a year, although more frequent reporting may in some cases be necessary to comply with Articles 1.2.0.2 and 1.2.0.3 of the *International Animal Health Code*.

Anthrax

Aujeszky's disease

Echinococcosis-hydatidosis

Leptospirosis

Rabies

Atropic rhinitis

Porcine cysticercosis

Porcine brucellosis

Transmissible gastroenteritis

Trichinellosis

Enterovirus encephalomyelitis

Porcine reproductive and respiratory syndrome

27.9 Schedule of Conditions for Import of Pigs

The pigs to be imported in India should accompany a valid health certificate issued by an authorized Government Veterinarian of Country of Import, which shall indicate that:-

“The country is free from Foot and Mouth Disease, Vesicular Stomatitis, Swine Vesicular Disease, Rinderpest, Rift Valley Fever, African Swine Fever, Classical Swine Fever, Aujeszky’s Disease, Peste des petis Ruminants and Entero Virus Encephalomyelitis”.

However, the schedule of conditions for the import of pigs into India from different countries would vary, depending upon the disease situation of the country of Import and India at the time of submission of application for license to import pigs.

28. WILD BOAR

Wild boar is the most noble and is the bravest of all the wild animals of the jungle. He is known for strength, adaptability and intelligence. A famous poet "**Thoedora Lau**" has praised the boar in following immortal phrase:-

*"Of all God's children
I have the purest heart
With innocence and faith
I walk in Love's protective light
By giving of myself freely
I am richer and twice blest.
Bonded to all mankind by
Common fellowship,
My goodwill is universal
And knows no bounds.
I AM THE BOAR."*

The wild pigs lack in grace and beauty but they are known for their strength, adaptability and intelligence. They are admirably adapted to range the forests, thickets, woodlands and grasslands. They are the most generalized of the living even-toed hoofed mammals and have a simple stomach. The living wild pigs are medium sized artiodactyls characterized by a large head, short neck and powerful, but agile, body with a coarse bristly coat. The eyes are small and expressive ears fairly long. The prominent snout carries a distinctive set of tusks (lower canine teeth) and ends in a mobile, disk-like nose pierced by the nostrils. The structure of the snout, tusks and facial warts is intimately linked to diet, mode of feeding and fighting style. The tasseled tail effectively swats flies and signals mood.

The wild pigs are the oldest and the most primitive even-toed ungulates. They have teeth characteristic of omnivorous animals. Their diet is extremely varied, as they eat tubers, bulbs, grass, leaves, sprouts, fallen fruit, seeds, juicy herbs and mushrooms. Food below the surface is dug out with the snout. They are able to find food quickly even deep in ground due to their extraordinary sense of smell. They also eats worms, the

larvae of insects, eggs and young birds, snakes, lizards and small rodents.

28.1 Grand Old Warrior and Protector of Jungle

28.1.1 Grand old warrior of the Indian Jungle

The Indian wild boar is the grand old warrior of the Indian jungle and hero of many encounter with tiger. It has very powerful lower tusks exceeding 30 cm. Dunbar Brander wrote in “Wild Animals in Central India”, I once saw a very large boar come trotting out of a beat alongside a full-sized male tiger, sharing the same path with him, and although the fact of their being hunted by man usually induces a temporary truce amongst animals.

The strength of the Indian wild boar is enormous, especially in the neck and shoulders, and the rapidity with which he can inflict terrible wounds on an opponent is almost unbelievable.

28.1.2 Wild Boar as Protector of Forests

The wild boar is extremely useful for the forest, as it eats considerable quantities of tree parasites, mainly the larvae of many parasites which are harmful for the trees. The digging and rooting is useful loosens the soil in large areas and actually buries seeds at times, thus plays an important role in regeneration cycle.

28.2 Wild Boar in Art & Culture

Wild Pig is regarded as one of the most bravest and interesting Hero of “*History of Shikar*”. It is shown in old historical paintings and many of these paintings are preserved in the Indian Museums.

The wild boar was sacramentally eaten by the Rajputs, indicating the dualistic attitude towards the pig. Wild pigs are of common occurrence throughout these parts, and it is possible that in old days they existed in large groups that roamed the countryside in search of food. At the present day in and around the city of Bikaner in the Rajputana desert the wild boar thrives, and each night large numbers of them wander into the city to feed on the refuse and other matter that has been thrown out by the inhabitants.

In natural history paintings the wild boar is shown in different moods.

28.2.1 Wild Boar in Indian Religion

The highest tribute paid to the valiant boar, in the Varaha aspect of Vishnu. The Varaha is styled Yajnavaraha or sacred like the sacrificial fire. This aspect of Vishnu as Varaha is specially marked by the depiction of the entire universe including the celestial sphere, all the gods represented on the body of the animal. The huge Varaha bristles with unending rows of celestials, marked on every inch of his body. God Varaha reached the underworld to rescue the earth that was submerged by a demon Hiranyaksha. A huge snake is shown at the feet, to indicate the a body of the snakes, the nether-world.

28.2.2 Wild boar in Prehistoric Cave Paintings

Wild boar is also depicted in cave paintings of Bhimbetka (India).

28.2.3 Wild Boar- in Indus Valley Civilization

A toy modeled on a wild boar has been recovered from Mohenjo-Daro. The remains of pigs were also found at Mohenjo-Daro. "*The pig was present in large numbers in this area from the very earliest time when Mohenjo-Daro was flourishing city,*" states **Marshall**. "But it is impossible to determine whether or not this animal was actually domesticated or even whether it was used as a source of food by the inhabitants in those far-off times. At the present time, pigs are the common occurrence throughout these parts, and it is possible that in the old days they existed in large herds that roamed the countryside searching for food.

28.2.4 Wild Boar During Mughal Period

According to **Abul Fazl**, the wild boar was much hunted in the Sarkar of Tattah (Sind) where it is still plentiful and a serious pest to cultivation.

Akbar had a special game department and caused an account to be kept of all the animals hunted with measurements and the minutest details concerning them.

Like his father, **Jehangir** also caused minute records to be

kept of his hunts with particulars as to the bag etc. The registers showed that from the twelfth year of his age to this fiftieth lunar or forty-eighth solar year, 17,167 animals had been killed by the Emperor himself, including 90 wild pigs. Jehangir mentions that two pigs formed part of his bag in Qamargah hunt which took place at Rawalpindi.

Sir Thomas Roe, the English Ambassador from James I to the court of **Jehangir**, mentioned that on one occasion the King returning from a hunt “**sent me a wild boar so large that he desired the tusks might be sent him back for their extraordinary size**”.

28.3 Classification of wild pigs

Wild pigs and boars belongs to family Suidae, and have nine species in 5 genera and placed in order Artiodactyla. It is found in Europe, Asia, E. Indies, Africa, North and South America, Australia, Tasmania, New Guinea and New Zealand.

They can be divided into two families:-

28.3.1 Suidae

Their head is relatively large, short neck and mostly short legs. These have incisors in both jaws, which vary in number, the lower ones slanting forward. Their canines are very large and directed outwards and upwards in a curve, grinding against each other to a sharp edge and fine point. Their metacarpal bones are four in number and are all distinct. The hogs have a prolonged snout, flexible at the end, with a firm cartilaginous tip, with which they are enabled to plough up the ground in search of roots. They have a very keen sense of smell. The normal dentition of the true hogs is as follows:-

Incisors, 6/6; canines, 1-1/1-1; premolars, 4-4/4-4; molars, 3- 3/3-3= 44

The Head-rump length from nose to base of tail is 50-200 cm, the tail length is 3.5-5 cm, the body height is 25-110 cm, and the weight exceeds 300 kg. Hogs are noted for their fecundity.

28.3.1.1 Genus *SUS*

They have incisors, 4/6 or 6/6; the lower ones slanted; the

canines large and curved outwards and upwards; molars tuberculate; four toes on each foot- that is, two major and two minor, each hoofed.

There are 5 genera (bush pig, wild boar, wart hog, giant forest pig and babirusa with eight species and seventy six sub-species.

28.3.2. Tayassuidae (Peccaries)

The family Tayassuidae (peccaries) was separated from pigs not later than in Oligocene era. Their fossils have been found in Eurasia and even in Africa. The modern species are only habitat of Americas. They have a snout disc. The stomach is subdivided into three compartments, and digestive system resemble ruminants. They have three hoofs on their hind legs. The total number of teeth are 38 and upper canine teeth point downwards and they have a scent producing gland located on their backs. These are significantly smaller than pigs with an average body size of approximately 30 kg.

This family includes 3 genera and 3 species, i.e. the Collared Peccary (*pecari tajacu*) spread across South and Central America and the southern part of North America. The diploid chromosome number is 30. It had been used widely for hunting due to its tasty meat and leather quality.

The White Lipped Peccary (*Tayassu pecari*), which is bigger than the Collared Peccary. It has a diploid chromosome number of 26 and habitat of southern Mexico to the south in Central America.

The Chacoan Peccary (*Catagonus wagneri*) is habitat of Paraguay Bolivia-Argentina border. It has a chromosome number of 20.

28.4 Habitat and Characteristics

28.4.1 Habitat

They live in large parts of Europe, Asia, and Africa. Wild boar, has been introduced by man to North and South America, Australia, Tasmania and New Zealand. Their habitats are the plains as well as alpine country. They like to live in forests, steppes, savannahas, swamps. Their habitat have water lakes,

puddles and banks of rivers and ponds. They used to take bath in mud. They find shelter in brush, bushes, reed and high grass, in dens, between the roots of the trees or in caves. They regularly visit places where they rub their bodies. They also prefer salt licks.

28.4.2 Distinguishing Characteristics of Wild Pigs

- ☐ The head is a more or less stretched, oblique cone-shaped, terminating in a movable snout with a cartilage disc that is practically hairless and contains many glands and the nostrils.
- ☐ Strange looking skin structures are found on the facial part of the head, warts, humps or pads.
- ☐ The small eyes are situated higher or lower.
- ☐ The ears are small to medium size, usually ending in a point.
- ☐ The rump is straight and is higher than it is wide.
- ☐ The legs are short and graceful.
- ☐ More or less dense coat of bristles with or without fleece is present in most of the species.
- ☐ The neck or back mane stands erect when the pig is excited.
- ☐ The cranium is bulky and the body skeleton is rather light and delicate.
- ☐ The scapula is long and wide.
- ☐ Pigs are omnivorous.
- ☐ They have 44 teeth or fewer teeth in some cases. The canines bent upward and hollow like a tube, are well developed in boar, which grow continuously.
- ☐ The piglets are brightly striped and dotted coat.
- ☐ The longevity in wild pigs is 15 to 25 years.

28.5 Behavior of Wild Pigs

The wild boar delights in cultivated situations, but he will not remain where water is not at hand, in which he may, unobserved, quench his thirst and wallow at his ease; nor he will resort for a second season to a spot which does not afford ample cover, whether of heavy grass or of under wood jungle, within a certain distance, for him to fly to in case of molestation, and especially to serve as a retreat during the hot season, as otherwise he would find no shelter. The sugarcane is his great

delight, both as being his favorite food and as affording a high, impervious, and unfrequented situation. The breeding sows, which not only devour, but cut the canes for litter, and throw them up into little huts, which they do with much art, leaving a small entrance which they stop up at pleasure. Sows never quit their young pigs without completely shutting them up. This is, indeed, requisite only for a few days, as the young brood may be seen following the mother at a round pace when not more than a week or ten days old. The field of urhar or ruhur dal (*Cajanus Indicus*) also afford good shelter to pigs. They feed chiefly at night on vegetable diet but will not hesitate to devour carrion if it should come across a dead animal in its wanderings.

28.5.1 Locomotion

Many species, if they find enough food, they remain in that locality which comprise of feeding areas, water holes, and wallows. They may also roam over great distances in search of food. The usual form of locomotion is trot over short distances and long distances can be covered by fast galloping. They are excellent swimmers and can even cross rivers and channels of several kilometers.

28.5.2 Communication

Pigs can communicate by squeaking and grunting sounds. One can distinguish various calls for maintaining contact, calling young piglets and others, alarm, attack, mating and distress. They can also produce different snorting and sneezing sounds. They can also produce sound with their teeth. They have a poor vision and can see at short distances only. The sense of smell is well developed.

28.5.3 Social Behavior

All wild pigs are gregarious animals, living together in pairs or in group. The focus of the group is usually a female with young piglets. Older boars often live alone except during mating season. At preferred feeding places or on migration, the groups may form herds of considerable size.

28.5.4 Protection and Fighting

Boars use their canine teeth as defensive weapons against

predators. In minor conflicts, pigs bite the opponent or push him away with their snout. Serious fights occur mainly between adult boars during the rutting season. The boars use their sharp canine teeth for tearing and slashing. They attack each other either frontal or from the side.

28.5.5 Reproductive Behavior

In moderate climates, the pigs have rutting season, while in tropical climate, pigs may mate all year round. In tropics reproduction is determined by the rainy season. Prior to copulation, a special ritual occurs where the boar causes the female to stand still by making special sounds and by massaging her with his disc-like snout. They have one litter per year, but in favorable conditions, they may have two also.

28.5.5.1 Mating Behavior

The puberty in wild gilts varies from nine months to twelve months of age. Pigs may breed throughout the year in the moist tropics but in temperate and tropical areas of marked seasonality. The courtship consists of special form of behavior performed by sow or gilt and boar. The sow searches for a partner and during heat it attains a standstill posture and allows the boar to mount. The mating occurs in the fall the sow farrow the following spring.

28.5.5.2 Nesting

Females usually separate from the group before giving birth. They seek a sheltered, dry place and dig a cave or a depression which they may line with various plant materials. They even build a roof over their nests.

The piglets are born in rapid succession. The piglets are small and 'rounded' in shape. After reaching the ground, they immediately starts crawling. The movement results in the severing of the umbilical cord and may tear anywhere along its length. Sows do not clean placenta or clean or lick the piglets.

28.5.5.3 Suckling Behavior

Immediately after the birth, the young piglets begin searching for the nipples of the lying mother, massaging her udder with their snouts. While suckling, the little piglets quarrel

frequently at first because each tries to obtain the nipple with the most milk for itself. However, after some time they establish a stable hierarchy in which each piglet has his own specific nipple.

28.5.5.4 Piglet Care

Young piglets have only a few hairs and require an extraordinary amount of warmth. During their first few days, they do not leave the nest but lie together near the mother, who usually stays with them. Female sow with young piglets is more alert and aggressive than many other ungulates. Piglets are nursed for two to three months, but they soon start to take other food in addition to the mother's milk.

28.5.5.5 Wallowing Behavior

Pigs are very fond of wallowing in which they like some shallow water over the mire, and not merely mire for this purpose. A very big boar lying in 3-inch deep water in a puddle on a forest road, soon after heavy rain, rolling over and squirming about so violently like that, the animal had been seized with a fit. The pigs wallowing in shallow, dirty water rub their sides and hindquarters well into the mire to get them scrubbed with squirming and rolling movements.

The wallowing differ from other animals like to wallow in that they like some shallow water over the mire, and not merely mire. They used to drink water at mid-day, in the afternoon and late in the evening.

28.5.5.6 Behavior of Indian Wild Boar

Wild pig seen by day are extremely fugitive and bolted at the sight or scent of man. Pig running away do not turn round for visual confirmation of a scent warning or to see if they are being followed. They change direction suddenly in flight and take advantage of every dip and bit of cover to disappear from view. The male is aggressive and even attacks human-beings.

Feeding Behavior

They also used to hunt frogs and insects in the soggy grass. They do eat a variety of animal prey, but the bulk of their food is vegetarian and much of it the underground stolons, rhizomes,

corms and bulbs of plants. The wild pig can dig up the ground with their snout. A groundnut field visited overnight by pig, looks as if it had been freshly ploughed up. They eat tender tall grass and root for the stolons and rhizomes of sedges and grasses.

These pigs are crop-raiders, and do substantial damage to groundnut, digging up an entire field overnight.

28.5.5.7 Courage of Wild Boar

The boar possesses a singular amount of courage. He is probably the most courageous of all animals much more so than the tiger, but unless irritated he is not prone to attack at first sight. A old boar is generally the chief. There are many instances of tigers being killed by boars.

Shakespeare's opinion about boar:-

*"To fly the boar before the boar pursues
Were to incense the boar to follow us,"*

Kinloch, when hunting with the Meerut Tent Club, had his horse ripped, himself thrown and wounded by the boar in 50 places.

Praise of the Boar

"It can be said the finest and most spectacular animal of the Indian jungles is the tiger, the most noble in appearance the elephant; but the consensus of opinion is that the Indian wild boar is the bravest and most gallant of all." Nothing for size and ferocity could surpass, if it could equal, the pure Bengali breed; *"No man who has not been an eye-witness of the desperate courage of the wild hog would believe in his utter recklessness of life, or in the fierceness that will make him run up the hunter's spear, which has passed through his vitals, until he buries his tusk in the body of the horse, or, it may be, in the leg of the rider"..." The hunter loses his seat at the peril of his life."*

28.6 Sub-species of Wild Pigs

There are thirty-two sub species of wild boar, some of the important sub-species of wild boar are as follows:-

28.6.1 Eurasian Wild Boar (*Sus scrofa scrofa*)

Wild pig of Europe (*Sus scrofa scrofa*) has more luxuriant

dorsal ridge of bristles than Indian wild boar (*Sus scrofa cristatus*).

It is found in Europe, North Africa, Sumatra, Asia, Japan, Taiwan and North America, Australia, New Zealand, North and South America. Native names are Guraz or Kuk, Persian.

Its relatives are restricted to India, East India and Indonesia. They are active in daytime and twilight. The short dense winter coat and no facial warts. The gestation period is 115 days. The sows have 6 pairs of mammae and longevity is 15-20 years.

It feed on a wide range of plant species like fungi, ferns, grasses, leaves, roots, bulbs and fruits. It also take insect larvae, frogs and mice and earthworms. They root for much of their food in litter and moist earth.

Size

The head-body length is 90-180 cm, and tail length is 30-40 cm. and weight varies from 50 to 200 kg. The body height is 55-110 cm. The body is dusky or greyish-brown, with a tendency to black with black spots. The mouth is large with long projecting tusks. The large head makes up about one third of the Head-rump length from nose to base of tail. They have a short and bulky neck and the rump is relatively short, massive and compact. The skull is massive and cone shaped. The coat is brownish-gray with bristles. The hairs of the body coarse, mixed with a downy wool, bristles are on the neck and shoulders. The head-body length from 130-210 cm in the giant wild boar. The weight in giant wild boar varies from 130-275 kg. The young are marked with longitudinal stripes of reddish colour.

Morphological characteristics

The key features of wild pigs are the well developed, unturned canines, molars with rounded cusps and a prenasal bone, which supports the nose. Pig walk on the third and fourth digits of each foot, while the smaller second and fifth digits are usually clear of the ground.

The senses of smell and hearing are well developed. Pigs are highly vocal and family group communicate incessantly by squeaks, chirrups and grunts. A loud grunt may herald alarm,

while rhythmic grunts characterize the courtship chant.

Captive Breeding

The global captive population of Eurasian wild pigs is 105 in 32 institutions (ISIS, 1993).*

28.6.2 The Indian Wild Pig (*Sus scrofa cristatus*)

The Indian Wild Pig (*Sus scrofa cristatus* Wagner) is found throughout India. The native names of Indian wild boar are *Soor* or *Suar*, *Bara-janwar* or *Bad-janwar*, *Barha* or *Varah* (Hindi); *Dukar* (Mahratti); *Paddi* (Gondi); *Pandi* (Telgu); *Handi*, *Mikka*, *Jewadi* (Canarese); *Kis of the Bhaugulpore hill-trives*; *Tan-wet* (Burmese); *Walura*, (Singhalese). The photographs of Indian wild boar are shown in Fig. 28.6.2.1 to 28.6.2.5.

Distribution

The Indian wild boar is commonly found in low jungles or forests and on the Himalayas. Its habitat is throughout India, from a considerable elevation of 12,000 feet to the sea level. It is also common in Burma and in Ceylon. Generally it exceeds 136 kg in weight. Wild boars found in West Bengal are heavier than those of Punjab and Deccan.

The Indian wild pig is also found in the Siwaliks and the tarai area throughout northern India. It lives in tall grass or scanty bush jungle.

Morphological Characteristics

The wild pigs lack in grace and beauty but they are known for their strength, adaptability and intelligence. They are admirably adapted to range the forests, thickets, woodlands and grasslands.

They are the most generalized of the living even-toed hoofed mammals and have a simple stomach. The living wild pigs are medium sized artiodactyls characterized by a large head, short neck and powerful, but agile, body with a coarse bristly coat. The eyes are small and expressive ears fairly long. The prominent snout carries a distinctive set of tusks (lower canine teeth) and ends in a mobile, disk-like nose pierced by the nostrils. The structure of the snout, tusks and facial warts is intimately linked to diet, mode of feeding and fighting style. The tasseled

tail effectively swats flies and signals mood. The boar is considerably larger than the sow. The height of well grown boar measures at 3 feet and its weight around 500 lb.

The key features of wild pigs are the well developed, unturned canines, molars with rounded cusps and a prenasal bone, which supports the nose. Pig walk on the third and fourth digits of each foot, while the smaller second and fifth digits are usually clear of the ground.

The head of Indian wild boar is larger and more pointed and the plane of the forehead is straight, while it is concave in the European. The ears are small and pointed. The tail is more tufted and the malar beard is well marked. The Indian wild boar is most active-looking animal.

The wild pig has a long snout, short ribs and long legs. It is rusty in colour when young, but with advancing age becomes dark chestnut-brown. The hair being tinged with grey at the extremities. It has a sparse coat, with a full crest and a mane of black bristles running from the nape down the back. The tusks are well developed in males and project from the mouth. The pig is extremely active, and when provoked may attack humans. It is highly prolific and breeds in all seasons. The diet consists of roots, tubers, insects and snakes.

The shoulder height ranging from 70-90 cm and the weight from 90-135 kg. The nuchal crest or mane is well developed. The body coat is scanty and devoid of underfur. The lower tusks of the boar reach a length of 25 cm and are kept with sharp edges by wear against those of the upper jaw.

The colour of the full-grown pig is brownish-black, sparsely clad with black hair; the ears are scantily covered with black hairs externally, but more abundantly inside. A crest of stiff black bristles extends from the occiput over the neck and shoulders and down the back; the bristles of the throat and breast are reversed, growing forwards instead of backwards. The tips are sometimes white. The limbs, which are well covered with bristly hair outside, are nearly naked within, and the tail is short, slightly hairy, and with a flat tip fringed with lateral bristles set like the

barbs of a feather. The young are more hairy and are striped with brown and fulvous yellow.

The Cranium and Tusks

The cranium of *Sus scrofa cristatus* is distinguished from that of *Sus scrofa scrofa* by its lesser length. The skull is massive and cone shaped. The occiput is more steeply elevated, the forehead is convex, the profile at the posterior end of the nasals often slightly concave. The palate is broad, and the lacrimal are short and high with the superior and inferior sutures of nearly equal length. The short upper canines have three edges, they emerge first towards the side and then bend upwards and back with advancing edges ending in a pointed tip. In females the canine teeth are much weaker. The lower tusks of the boar reach a length of 25 cm and are kept with sharp edges by wear against those of the upper jaw. The *sus scrofa cristatus* craniums in the Mizo Museum, at Aizwal, Mizoram (India) combines the peculiarities of its race.

Sense Organs

The senses of smell and hearing are well developed. Pigs are highly vocal and family group communicate incessantly by squeaks, chirrups and grunts. A loud grunt may herald alarm, while rhythmic grunts characterize the courtship chant. Smell is the prime sense and sight and hearing are only fair. Sow build regular nests of tall grass for their accouchement.

Pigs are well able to make out moving objects from a distance. When suddenly warned of danger by smell or otherwise, the erectile ridge of hair from the forehead to the hindquarters bristles and stands up suddenly.

Communication

The senses of smell and hearing are well developed. Pigs are highly vocal and family group communicate incessantly by squeaks, chirrups and grunts. A loud grunt may herald alarm, while rhythmic grunts characterize the courtship chant.

Speed

In spite of their mass and extraordinarily thickset build, pigs are agile and capable of considerable speed. The big boar

can leap easily over a bush, up to 3 foot high. Pig walk on the third and fourth digits of each foot, while the smaller second and fifth digits are usually clear of the ground.

Reproduction in wild pigs

It is highly prolific and breeds in all seasons. Sexual maturity is attained at about 18 months, although males may only gain access to sows on reaching physical maturity at about 4 years old. Pigs may breed throughout the year in the moist tropics but in temperate and tropical areas of marked seasonality. The mating occurs in the fall the sow farrow the following spring. The young one are born in a grass nest constructed by the sow and weigh between 500 to 900 g. The piglets remain in the nest for about 10 days before following their mother. Each piglet has its own teat. Weaning occurs at about three months of age, but young piglets remain with their mother in a closely knit family group until she is ready to farrow again.

Nesting

Sow build regular nests of tall grass for their accouchement. The old nests are abandoned after one farrowing and are visible in the neighborhood of regular nests.

Meat Qualities of Wild Boar

The wild pig is a poor producer of pork products. The meat is however delicious.

Food habits

The diet consists of roots, tubers, insects and snakes. They used to eat a variety of animal prey, and carrion, but the bulk of their food is vegetarian and much of it the underground stolons, rhizomes, corms and bulbs of plants. They used to drink water at midday, in the afternoon and late in the evening. They also used to hunt frogs and insects in the soggy grass.

It is astonishing the way pig can dig up the ground with their snout. A groundnut field visited overnight by pig, looks as if it had been freshly ploughed up. They eat tender tall grass and root for the stolons and rhizomes of sedges and grasses.

Damage to the Plantations and crops

The wild boar may cause considerable damage to fields

and plantations in densely populated areas. The damage to the crops is mainly due to his efforts for tireless rooting in the ground.

28.6.3 Wild Boar (*Sus Scrofa Vittatus*)

It is distributed in the Malay Peninsula, Java, Sumatra and a neighboring islands. It is distinguished by dark brown colour, variegated with reddish brown and a black spinal stripe, rising into a crest on the neck, where the bristles are tipped with rufous. Typically a broad reddish brown band extends along the middle of the muzzle, broadening at the angles of the mouth and on the sides of the upper lip, and disappearing backwards on the sides of the neck. The face is devoid of warts or tufts of hair. The muzzle is short and the ears are moderately long. The tail tuft is small and flattened. The cranium is of medium length and width, but of great height, owing to the marked depth of the mandibles. The lower canines, triangular in the transverse section, have the outer surface considerably shorter than the posterior surface.

28.6.4 Blyth (*Sus scrofa andamanensis*)

It is found in the forest of Port Blair, Andaman Islands and Bay of Bengal.

Blyth is the wild boar found in the forests of Andaman Islands. There are 22 subspecies of *sus scrofa* Linn. and Andaman wild pig is the smallest of the wild pigs.

The concavity of the cheeks in front of the orbit deeply concave, tail short, a mere tubercle in fact. The body is well clad with somewhat shaggy black hair. The skull of this species is more alike to *Barbirussa* than any others of the pigs, the front of the canines being rather more produced than in other species.

It is much smaller than the mainland pig. The tail is very short, as long as the hind foot, with a brown tuft. The coat is black, covered with somewhat shaggy long bristles. Indistinct crest present over neck and back. The snout is elongated terminating in a truncated, mobile, flat disc bearing nostrils. The piglets striped. The height at the shoulder is 50 to 53 cm. It lives in forest and comes out for feeding on cultivated crops. It feeds mainly on roots, tubers, seeds, insects, offal and the carrion.

Distribution

It is known from Andaman Islands i.e. Middle, South and Little Andaman and Havelock Islands.

Status and Conservation measures

The population of the Andaman wild pig is in vulnerable state in the last few decades. It is enlisted in Schedule I of the Wildlife (Protection) Act 1972, hence legally protected from killing.

Andaman Wild Pig in Wildlife Sanctuaries/ National Parks

Efforts are being made to breed Andaman wild pig at Mount Harriett and Saddle Peak National Park and wildlife sanctuary of Andaman and Nicobar Islands.

28.6.5 Pigmy Hog (*Sus salvanius*)

The pigmy Hog *Sus salvanius* was first recorded in 1847 and was described by **B. H. Hodgson** in his paper “*On a new form of Hog Kind or Suidae*” in the May edition of the Journal of the Asiatic Field Society, Bengal. Hodgson stated that it must seem almost incredible that so tiny an animal should effectually resist men,

The native names of Pigmy hog are *Sano-banel* (Nepalese); *Chota-suar* (Hindi). The Assamese local name for pigmy hog is “*Nulgahuri*”.

Distribution

It is found in the dense, moist forests of Sikkim, Siwalik foothills of Nepal, Bhutan and in Durars of Northern Assam. It is nocturnal in habit. The pig prefers to remain in high grasses and is rarely seen. It lives in herds of 15-20. The length is 66 cm from snout to rump. The weight is 7-8 kg and colour is brown-black.

Description

The pigmy hog is about the size of a large hare, and extremely resembles both in form and size of a young pig of the ordinary wild kind of about a month old, except in its dark and unstriped pelage. The jaws are shorter and eye consequently placed midway between the snout and ear. The tail is also much shorter, nude, straight and not extending so far as the bristles of

the rump, and inner hind toe are small.

The colour of the pigmy hog is blackish brown shaded vaguely with rusty red, the hairs are quite sparse in comparison of a Wild boar or a Peccary and hairs don't exceed 2.25" in length. Both the ears are short and without hair, and the jaws are shorter than those of the common Hog. The females have only three pairs of teats, i.e. half the number possessed by other pigs. The young piglets are dark brown, with longitudinal rufous bands above and on the sides. The young piglets have greyish hairs about the snout, forehead, crown of head and ears. The dorsal hairs are blackish brown tinged underneath with rufous. The hairs under the throat and on the stomach were predominantly rufous. The skin has a grey pigmentation. The length from snout to base of tail for sub-adult is 18-20" with shoulder height of 8-10" weighing 7-10 lbs. The mature adult boar length measures 26" with shoulder height of 12".

Hodgson (1847) states that the pigmy hog seems to have the disposition of the peccary (*Tayassu tajacu*) as well as the resemblance. The herd consists of 5-6 to 15-20. The males fearlessly attack intruders, charging and cutting the naked legs of their human or other attackers with a speed that baffles the eyesight, and a spirit which their straight sharp laniaries renders really perplexing. The elephants, often enough, are scared to death by the pigmy hogs, for the little creatures have tusks as sharp as razors, and gash the elephants' feet with them as they rush past them.

Hamilton (1921), describing a shooting expedition with the Maharajah of Cooch Bihar in 1891, states that they go about in droves of about fifty, and move through the grass with such incredible rapidity that the eye is unable to follow them.

The pigmy hog is nocturnal, however they are most active just after dawn and some two hours before sunset. They chiefly found in tall grass jungles and is said to live in group of 5 to 20 individuals. It's food comprises of roots, bulbs, insects and birds' eggs. Adult male joins the oestrous female from late December to early February. Birth has been recorded during April- May

and September. In captivity, the litter size varies from 2 to 6.

Nesting

Just prior to giving birth the females are said to make a nest within the thatch.

The litter consists of usually 3-4 piglets, and produce two litters a year. The gestation period of sows is 110-120 days. The mammae comprise of 3 pairs. The longevity of pigmy hog is 10-12 years.

Food Habits

The main diet of pigmy hog is roots and bulbs but also eat eggs, young birds, insects and reptiles.

Threats to Survival

The pigmy hog's habitat is threatened by an increasingly intensive human development. When the area becomes water-logged, the pigmy hog go into the forested areas of the foothills. Its population is not exactly known but appears to be extremely low. An estimated 100 to 150 individuals are said to survive in north- western Assam. There was 500 pigmy hogs during 1983-84 in Manas Biosphere Reserve.

Conservation and Protection

It is highly endangered species due to decimation of its population. The species is enlisted in Schedule I of the Wildlife (Protection) Act 1972.

Efforts are being made for the conservation of this species in its natural habitat, specially in the Manas Wildlife Sanctuary and Baranadi and Nonai Reserve Forests in Darrang district of Assam.

Under "**Pigmy Hog Conservation Programme**", in 1996 six wild hogs were caught from Manas National Park and transferred to a custom built research and breeding centre built at Basistha near Guwahati. Currently 51 hogs consist of 28 males and 23 females are present at the Research and Breeding centre.

28.6.6 Javan warty pig (*Sus verucosus*)

It is found in Java, Madura and Bawean. The habitat of Javan warty pig is forest lowland grasslands and swamps. The head-body length is 90 to 160 cm. The weight may be up to 185

kg. The coat is red or yellow with hair with black tips, marked facial warts. The gestation period is 115 days and longevity is 15-20 years.

28.6.7 Bearded pig (*Sus barbatus*)

The habitat of Bearded pig is Malaya, Sumatra and Borneo. Its habitat of tropical forest, secondary forest and mangroves. It is active during daytime.

Its coat is dark brown-gray with distinctive white beard on cheeks. It has marked facial warts. The head-body length varies from 90 to 180 cm. The gestation period of sows is 115 days. The longevity is 15 to 20 years.

28.6.8 Sulawesi Warty Pig (*Sus celebensis*)

It is found in Sulawesi. Its habitat is lowland and upland tropical forest. Its size is smaller than bearded pig. The facial warts are well developed.

Distribution and Status

It occurs in Sulawesi and some adjacent islands. It has been introduced onto some of the Lesser Sunda and West Sumatran Islands as a domesticated and feral form.

Threats to Survival

In the wild, hunting, deforestation and disturbance due to human settlement are the main threats. Its population is declining due to uncontrolled hunting.

Captive Breeding

The genetic variability within the species as well as the karyotypic differences from other *sus* species and hybrid need definition. There are no Sulawesi warty pigs in captivity (ISIS, 1993).

Economic Importance

The Sulawesi warty pig has been exploited since pre-historic times for meat. The tusks can be carved like ivory and wild Sulawesi warty pig is considered a suitable trophy for sport hunting.

28.6.9 Babirusa (*Babyrusa babyrussa*)

It is found in Sulawesi, Togian, Salu and Baru Islands. Its habitat is tropical forest. They are active during daytime. The

head-body length is 85 to 105 cm. The height of the tail varies from 27 to 32 cm. The weight is up to 90 kg. The coat appears, short, white or grey with bristles. There is no facial warts. The gestation period is 125 to 150 days. The female has only one pair of mammae. The longevity is up to 24 years.

It feeds largely on fruits and grass.

28.6.10 Bushpig (*Potamochoerus porcus*)

It is found in Subsaharam Africa and Madagascar. Its habitat is forest, moist savanna woodlands and grasslands. They are active during day and night. The head-body length is 100-150 cm. The height of tail varies from 30 to 40 cm. The weight varies from 50 to 120 kg.

The coat is brick red to gray bristles with white, often patterned, face and mane. The facial warts are found in male. The gestation period is 127 days. The female has 3 pairs of mammae. The longevity is 10-15 years.

28.6.11 Giant forest hog (*Hylocherus meinertzhageni*)

It is found in Central African Congo basin, parts of West and East Africa. The habitat is tropical forest and intermediate zone between forest and grassland. It grazes predominantly in evergreen pastures and forest glades, seldom digging with its snout. They are active during daytime. The head-body length is 130-210 cm. The height of the tail varies from 30 to 45 cm. The weight of the hog varies from 130 to 275 kg. The coat is brown and have black bristles. The facial warts are present. The gestation period is 149 to 154 days. The female have 3 pairs of mammae.

The face is strange like gorilla or a bat, but with tusks.

28.6.12 Warthog (*Phacochoerus aethiopicus*)

It is found in Subsaharan Africa. Its habitat is Savanna woodland and grasslands. They are active during daytime.

They have a barrel-shaped body, a big, wide head ornamented with odd skin warts, and huge canine teeth. The head-body length is 110-135 cm. The length of the tail is about 40 cm. The weight of the pig varies from 50 to 110 kg. The coat is black or white bristles on gray skin. It has pronounced facial



Fig. 28.6.2.1 The herd of Indian Wild Pigs



Fig.28.6.12.1 Warthog Boars



Fig.28.6.2.2 A Close-up of Indian Wil Boar at Sariska.

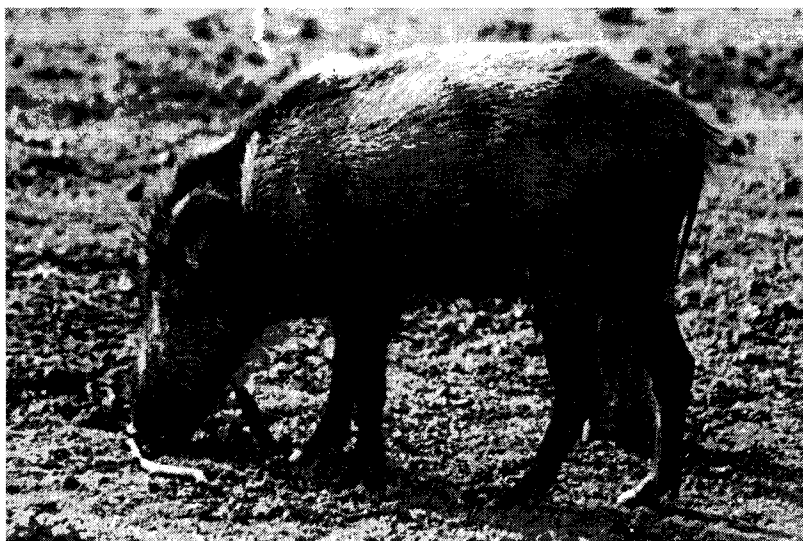


Fig.28.6.2.3 Indian Wild Boar showing long tail.



Fig. 28.6.2.4 A piglet of Indian Wild Boar.



Fig.28.6.2.5 An Illustration of piglet showing stripes.

warts. The gestation period is 170-175 days. The female has 2 pairs of mammae. The longevity is 12 to 15 years.

It has two pairs of tusks, the upper tusks are more impressive, but lower tusks are more sharper and are the warthog's principal weapons. The photograph of warthog is shown in Fig. 28.6.12.1.

28.7 The hunting of wild boar

The sport of chasing the wild boar on horseback with a spear was introduced by British sportsmen in Bengal in the later part of the eighteenth century. Pigsticking was the grandest sport in India, where the hunter shared, on almost equal terms, the danger with the hunted. It had a code of honour; the boar is hunted with respect and pursued on certain fixed principles.

28.7.1 Hunting of Wild Boar in India

Hunting of wild boar has been a favorite sport of Rajput kings and nobles from earliest times. The boar's head was brought into the dining halls with great ceremony in ancient and medieval times. The method of hunting of wild boar was preserved in the shape of paintings. Hunting of wild boar was one of the favorite subject of Rajput paintings. The larger boar was hunted on horseback. The hunter carried a spear and killed the boar by charging it, which was called "*pigsticking*" in India.

In 1776, a wild boar was hunted in the Dacca District. The spear used was 3 feet long and well poised and was thrown like a javelin. The throwing of spear was discontinued and penalized by the Calcutta Tent Club in 1930.

Modern Pigsticking was controlled by Meerut Tent Club and the Kadir Cup which was constituted in 1869 and winning of which has been the blue ribbon of pigsticking.

28.7.2 Hunting of Wild Boar in England

In England, during the ruling of Norman kings, anyone who killed a wild boar without royal permission might have his eyes put out. Some great estates in Europe still keep wild boar in their woods to hunt. Sports enthusiasts consider boar hunting on foot with hounds and spears exciting and dangerous.

An enthusiast has composed the following imperishable verse:

*“Youth’s daring spirit, manhood’s fire,
Firm seat and eagle eye,
Do they require who dare aspire
To see the wild boar die.”*

29.8 Protection of Wild Boar in India

India’s wildlife are our most magnificent natural heritage, preserved and protected since ancient times. The **Empire Ashoka** (3rd century B.C.) have detailed list of animals that should be protected. The Mughal Emperors like **Babur, Akbar, Jehangir** was the naturalists and they showed their love for nature and wildlife.

Now there is a complete ban on hunting of wild boar as per the Wildlife Preservation Act, and wild boar, wild pig and pigmy hog and Andaman wild pig are being protected in National Parks and wildlife centuries.

28.9 Wild Boar in Wildlife Sanctuary and Parks

28.9.1 Wild Boar in Wildlife Sanctuaries

Indian Wild Boar is also found in Ceylon and Indian range of Periyar sanctuary of Kerala, Mudumalai Sanctuary and Pt. Calimere Sanctuary of Tamil Nadu, Bandipur Sanctuary of Mysore, Kawal Sanctuary of Andhra Pradesh, Raigoda Sanctuary and Usha Kothi Sanctuary of Orissa, Hazaribagh and Palamau of Bihar, Kanha, Shivpur and Churna of Madhya Pradesh and Taroba of Maharashtra.

28.9.2 Wild Boar in Kanha National Park

Kanha is situated in the eastern sector of the Central Indian Highlands, ranges over an area of 940 Sq. Km. in the Maikal chain of hills. It is one of the largest and least disturbed areas of forest in India

Their is a very good chance or certainty of sighting a wild boar in Kanha National Park located in Madhya Pradesh.

These splendid beasts have dark grey, grizzly coats with a bristling black mane running along the spine. They are common

in the valleys throughout the Park, generally in sounders of 10-20 animals. Young pigs can be recognized by their smaller and lighter brownish colouring. The big boar, with their black coats and long, curved tusks, live singly or in pairs, congregating only in the breeding season when the large groups of boar and sows can be seen together. A large boar height at shoulder is 90 cm and weight is up to 230 kg. The piglets are born mainly two times in a year, just before and after the rains. The gestation period of sows is 4 months and 4-6 young piglets are born in one farrowing in a grass nest constructed by the mother. The food of preference includes crops, roots, tubers, insects, snakes, carrion etc.

Census Results

An annual census is conducted by the forest Department of all species of large mammal within the park. This gives a good relative index of year-to-year population changes. The wild pig population during 1975 was 1814, which increased to 3779 during 1978, and further increased to 5329 in the year 1982.

28.9.3 Wild Pigs in National Parks and Sanctuaries

Some of the important homes of wild pigs in India is as follows:-

State

Wildlife Sanctuary/ National Park

Andhra Pradesh ,

Nagarjunsagar, Srisailem,, Guntur, Prakasam, Kurnool

Assam

Kaziranga National Park, Jorhat, Sonai-Rupa, Tejpur

Bihar

Hazaribagh Wildlife Sanctuary, Bhimbandh, Monghyr, Palamau Wildlife Sanctuary, Dalmia Wildlife Sanctuary, Bamiaburu, Singhbhum

Gujarat

Gir National Park, Junagarh, Purana, Dangs

Himachal Pradesh

Shrinaina, Lilaspur, Simbalbara, Sirmur

Karnataka

Bandipur National Park, Mysore, Tungabhadra, Bellary,

Mukambika, South Kannada, Sharavathi Valley, Shimoga

Kerala

Ernakulam Rajamalai National Park, Idduki., Wynad, Cannanore & Kozhikod, Periyar Wildlife Sanctuary, Idukki

Madhya Pradesh

Kanha National Park, Kanha, Bandhavagarh National Park, Shivpuri National Park, Shivpuri, Bori, Hoshangabad, Game Sanctuary, Bastar, Sitanadi, Raipur, Achankmar, Bilaspur

Maharashtra

Borivilli National Park, Mumbai, Project Tiger, Amarya, Radhanagari Sanctuary, Tansa; Thane, Dakna-Kolkaz Sanctuary

Manipur

Reibul Lamjao National Park, Dampa Wildlife Sanctuary

Mizoram

Dampaaizawl

Nagaland

Intangki, Kohima

Orissa

Bhitarkanika Sanctuary, Cuttack

Rajasthan

Tiger Project, Ranthambore, Ghana Bird Sanctuary, Bharatpur, Darrah, Kota, Kumbhagarh, Ranakpur, Udaipur, Jodhpur districts.

Tamil Nadu

Mundanihura Tiger Sanctuary, Tirunelveli, Point Calimere Sanctuary, Thanjavur

Uttar Pradesh

Corbett National Park, Nainital, Govind Pashu Vihar, Uttar Kashi, Nandadevi, Cahmoli, Kishanpur, Lakhimpur, Kheri

West Bengal

Lothian Island, Sajnakhali, 24-Parganas, Gorumaraja Jalpaiguri, Jaldapara, Jalpaiguri, Mahanandi, Darjeeling, Sunderbans Tiger Reserve, 24-Parganas

28.10 Wild Boar in Zoos

28.10.1 Wild Boar in World Zoos

Zoo veterinarians have always dealt with wild pigs in zoos, national parks. Wild species of pigs such as wart hog, babirusa

and bush pigs are being maintained in zoos of United States of America.

28.10.2 Wild Boar in Indian Zoos

Wild boar is found in the forests and National Parks and it is being bred in captivity in Indian Zoological Parks. The management of wild boar in zoological park is not a easy task. The veterinary officers working in Zoos are responsible for management and breeding. Their proper breeding would help in increasing the number of wild pigs in zoos and National Parks.

28.11 Feeding of Wild Boar in Zoos

The food of wild boar is chiefly roots and bulbs but they also eat eggs, young birds, insects and reptiles, having a good deal of the omnivorous. The wild boars can be fed mainly on rice and vegetable matter. However, in order to provide the pigs with nutritionally adequate and balanced rations, the following foodstuffs are advised.

Papaya, Pumpkin, Tomato, Potato, Egg Plant, Cabbage, Corn on the Cob, Banana, Pea Nuts, Raw Egg with shell, Unpolished Rice, Skimmed milk, insects, reptiles, young birds, Becadex (Multivitamin preparations) and fresh turf with plenty of soil left around roots, and a few branches should be placed daily at regular intervals.

The corn on the cob was one of their favorite foods, for they would carry the cob about the paddock nibbling at them until only the husk remained.

28.12 Breeding of Wild Boar in Captivity

28.12.1 Captive Breeding of Eurasian wild pigs

The global captive population of Eurasian wild pigs is 105 in 32 institutions (ISIS, 1993).

28.12.2 Breeding of Pigmy Hog in Captivity

The record of the Zoological Society of London show that the number of young per litter ranges from 1 to 4. The South American Collared Peccary in the Jersey Wildlife Preservation Trust's collection, normally produce two litters a year consisting of from one to four young with a gestation period of 110-120 days.

28.12.3 Breeding of Indian Wild Boar in India

The Indian wild boar is being successfully maintained in captivity at National Zoological Park, New Delhi. During 1998, one sow farrowed one litter. The piglets were healthy and the coat was striped.

28.13 Chemical Immobilization of Wild Boar

Most of the tranquilizer and chemical immobilizing agents are used, however, availability and user experience may be the prime factors in drug selection.

Delivery Systems

1. Cap-chur system (Palmer Chemical)
 - a. Short range- CO₂ pistol
 - b. Medium range- CO₂ rifle
 - c. Long range-powder charge
 1. Brown charge- 20m
 2. Green charge-30m
 3. Yellow charge- 40m
 4. Red charge- 50m

Ketamine Hydrochloride

It is a derivative of phencyclidine hydrochloride and is a dissociative anesthetic agent for wild pigs. Brand names includes Vetalar (Parke-Davis, Detroit; 100 mg Ketamine Hydrochloride/ml in a 10 ml vial); Ketaset (Bristol, Syracuse, NY; 100 mg Ketamine Hydrochloride/ml in a 10 ml vial).

Dose for wild pigs is 15-20 mg/kg body wt.

28.14 Wild Pig is an ancestor of domestic pigs

The domestic breed of swine originated from wild *sus scrofa*, with domestication commencing in China over 4900 years ago. The indigenous or Desi pigs of India have come to as a distinct group as a result of gradual domestication of wild pigs to their surroundings. All domestic varieties, except the Chinese variety, are the descendants of the Indian wild pig. Pig Breeding originated in India and east Turkestan and spread through the Mediterranean region to Europe.

The Chinese variety is the descendant of *Sus vittatus*, found wild in south-east Asia. The European representative is the wild

pig (*Sus scrofa*). *Sus scrofa* and *Sus vittatus* are connected by transitional races found in the geographically intermediate areas. The Mediterranean races are intermediate between the European and the eastern Asiatic groups in several respects. It seems that the domesticated pig was repeatedly raised independently from the wild stock all over, wherever it is found.

29. RESEARCH AND DEVELOPMENT

Research played an important role in developing pig production throughout the World. Huge amount of work has been done on pig production to achieve maximum goal of lean pork production, high litter size, reduction in weaning time, reduction of mortality, high feed conversion efficiency etc. International breeding companies have their own research units, and genetic improvement of pigs is highly structured and very quick to adopt new technology.

Revolution in Computer technology also offers faster, cheaper and more accurate research on pig production and mixed model theory can harness the computer power to give more accurate prediction of research.

29.1 Research on Pig Production

The important points of research directly related to commercial pig production includes early maturity, litter size, weaning time, weight gain, feed conversion efficiency and lean meat.

Most of the research work on pig production is done by “All India Coordinated Research Project on Pigs” and College of Veterinary Science and Animal Husbandry located throughout the country.

The research work done on pig production in the World is very high and not possible to include in this small chapter, however some important research work done in the world on pig production is as follows:-

29.1.1 Breed

Title: Chinese pigs after 8 years.. good performance.

Author: Vrillon, J.L.; Caritez, J.C(1988).

Address: INRA, France.

Source: Cultivar-2000. 1988, No. 227, Supplement, 43-46.

Abstract: A discussion of the reproduction and meat production of Maishan, Jiaxing and Jinhua pig breeds in France and their economic superiority over European breeds.

Title: Results of experiments with Chinese pig breeds in France: reproduction and production.

Author: Legault, C; Caritez, J.C.; Gruand, J; Bidanel, J.P (1984).
Address: Station de Genetique quantitative et appliquee, 78350
Jouyen Josas, France.

Source: *15emes Journees de la Recherche Porcine en France*,
1984. 1984, 481-493; English and French summaries in
16emes Journees de la Recherche Porcine en France, 1984.
Resumes francais et anglais des communications, pp.131-
132. Paris, France; *Institut National de la Recherche
Agronomique*.

Abstract: For 216 European (Large White and French Landrace),
Maishan, Jiaxing, Jinhua, Maishan X Jinhua reciprocal
crossbred, Maishan X European, Jiaxing X European, Jinhua
X European, and Large White X (50% Maishan or 50%
Jiaxing) sows, litter size averaged 10.7, 14.9, 11.6, 11.6, 15.8,
15.3, 15.2, 11.7 and 11.5 resp., number of piglets weaned per
litter 9.2, 13.1, 10.0, 9.9, 13.4, 12.8, 13.2, 9.7 and 9.9, litter
weight at birth 14.7, 16.2, 9.5, 8.0, 15.2, 19.3, 15.8, 11.6 and
15.6 kg, litter weight at 21 days of age 56.8, 57.3, 38.5, 32.6,
56.1, 67.8, 64.5, 45.2 and 57.6 kg, and feed consumption by
the sow during 30 days of lactation 161.8, 101.1, 85.4, 75.6,
94.5, 130.0, 130.7, 114.8 and 118.7 kg. Differences due to
breed type were significant for all traits. For 356 progeny of
French Landrace (FL) X Large White (LW), Maishan X (LW
or FL), Jiaxing X (LW or FL), and Jinhua X (LW or FL)
sows, all mated to Belgian Landrace boars, age at 100 kg
body weight averaged 186, 171, 189 and 192 days resp., daily
gain between 30 and 100 kg 772, 742, 673 and 656 g, feed
conversion ratio 3.38, 3.59, 3.68 and 3.77, dressing percentage
75.4, 74.5, 75.1 and 76.6, carcass length 981, 975, 983 and
963 mm, muscle percentage 50.1, 46.1, 46.1 and 45.8, ham
weight 9.19, 8.66, 8.61 and 8.78 kg, loin weight 11.63, 10.73,
10.90 and 11.28 kg, backfat weight 4.19, 4.74, 4.73 and 5.12
kg, backfat thickness 23.6, 25.6, 23.9 and 28.4 mm, and meat
quality index 85.1, 85.4, 85.4 and 85.2. For 714 progeny of
50% Maishan, 50% Jiaxing, 50% Jinhua and 25% Maishan
or Jiaxing sows, mated to 3 unspecified types of boar, age at

100 kg averaged 154, 162, 170 and 152 days resp., daily gain between 25 and 100 kg 827, 793, 726 and 849 g, feed conversion ratio 2.96, 2.98, 2.96 and 2.79, dressing percentage 73.4, 73.6, 74.9 and 73.3, carcass length 953, 972, 955 and 961 mm, muscle percentage 43.5, 43.8, 41.6 and 47.8, ham weight 8.17, 8.06, 8.33 and 8.38 kg, loin weight 10.34, 10.41, 10.16 and 11.14 kg, backfat weight 5.52, 5.40, 6.09 and 4.71 kg, backfat thickness 27.0, 25.5, 28.7 and 24.3 mm, and meat quality index 86.8, 86.2, 84.3 and 85.6. There were significant differences among breed types for all traits.

Title: The performance of German Landrace pigs.

Author: Gabris, J.; Mattova, J.

Address: Vysoka skola veterinarska, 041 81 Kosice, Czechoslovakia.

Source: Zivocisna-Vyroba. 1985, 30: 7, 629-636.

Abstract: Records obtained in 1981-83 on 865 sows were analysed. Litter size was 8.57-9.20 for 1st litters and 8.29 for 8th litters, the largest litters being at the 4th parity (10.04-10.59). The percentage of stillborn piglets ranged from 0 (8th litters) to 1.39 (3rd). Milk yield ranged from 40.73 kg (8th lactation) to 50.95 kg (3rd). Daily gain of 981 barrows was 519-536 g, and backfat thickness 1.55-1.59 cm.

29.1.2 Factors of Pig Production

Title: Mathematical model for the evaluation of factors affecting the efficiency of use of sows.

Author: Prokoptsev, V.M.; Kuznetsov, V.M.; Grigor'eva, S.M.

Source: Vestnik Sel'skokhozyaistvennoi Nauki, Moscow, USSR. 1985, No. 6, 113-117.

Abstract: The model includes the effects on weaned piglet production per sow per year of the frequency of oestrus, CR, litter size, piglet survival during suckling, the durations of pregnancy, lactation and the interval from weaning to 1st oestrus, and the culling rates of production sows and tested sows. The model was validated using data from a commercial pig complex.

29.1.3 Housing and Management

Title: The reproductive performance of gilts in individual and group confinement systems.

Author: Abilay, T.A.; Acda, S.P.(1981).

Address: Department of Animal Science, College of Agriculture, University of the Philippines, Los Banos College, Laguna, Philippines.

Source: *Philippine Agriculturist*. 1981, 64: 1, 91-98.

Abstract: For 7 six-month-old gilts individually penned (floor space, 1.5 m²) and 8 gilts confined in a group pen (2.4m² per pig), age at 1st farrowing averaged 358.1 and 370.9 days resp., age at weaning 400.1 and 409.1 days, number of services per conception 1.0 and 1.4, gestation period 112.0 and 112.4 days, litter size (including dead piglets) 11.2 and 10.4, piglet weight at birth 1.2 and 1.1 kg, total litter weight 11.3 and 10.7 kg, and piglet mortality rate 18.0 and 9.0%.

29.1.4 Swine Improvement

Title: Pig production in Asia. 2. Breeding pigs for Asian conditions. Appendix. Improvement of swine production through breeding: a simulation approach for program planning and evaluation.

Author: Mi, M.P.(1987).

Address: Department of Pig Genetics, University of Hawaii, Honolulu, HI, USA.

Source: Extension Bulletin, ASPAC Food and Fertilizer Technology Center for the Asian and Pacific Region, Taiwan. 1987, No. 259, 35-41.

Abstract: The population structure, performance testing, selection, reproduction and growth performance in a typical pig breeding programme are outlined, with a view towards developing a simulation model that could be applied using personal computers.

29.1.5 Reproduction

Title: Reproductive performance of Large White Yorkshire pigs and their crosses with indigenous pigs in hot-humid climate of Orissa: a note.

Author: Mohanty, S.; Nayak, J.B. (1986).

Address: Animal Production Department, Orissa University of Agriculture and Technology, Bhubaneswar 751 003, India.

Source: *Indian Journal of Animal Production-and-Management*. 1986, 2: 3, 134-137.

Abstract: For 60 Large White (LW) and 40 LW X local sows, litter size at birth averaged 6.4 and 5.8 respectively ($P < 0.01$). There were no significant differences between the 2 groups in litter weight at birth or at weaning, or in litter size at weaning. Age at puberty in 35 and 25 gilts resp. averaged 192.4 and 237.8 days, at a live weight of 37.3 and 42.7 kg (both $P < 0.01$). Gestation length and oestrous cycle length were similar in the 2 groups, while the duration of oestrus averaged 72.4 and 82.3 h ($P < 0.01$). There were no significant differences between groups in the seasonal incidence of oestrus or farrowing. In both groups, season of birth had a significant effect on litter size, and parity had a significant effect on litter weight at birth.

Title: Reproductive problems and targets in commercial pig breeding units.

Author: Riley, J.E. (1986).

Address: Government Buildings, Brooklands Avenue, Cambridge, UK.

Source: British Society of Animal Production. Winter Meeting, 17-19 March 1986, Grand Hotel, Scarborough. 1986, Paper No. 56, 2 pp.

Abstract: Results for herds participating in the Cambridge Uni. Pig Management Scheme in 1985 are tabulated. For av., best and worst herds (based on total cost per weaner for breeding herds, and live weight gain in feeder herds), the number of litters per sow in the herd (q standard deviation) averaged $2.26q0.15$, $2.27q0.13$ and $2.19q0.14$ resp., the number of liveborn piglets per litter $10.5q0.56$, $10.7q0.64$ and $10.3q0.43$, litter size at weaning $9.1q0.62$, $9.4q0.74$ and $8.9q0.48$, number of weaners per sow in the herd $20.6q2.17$, $21.3q2.45$ and $19.4q1.73$, and age at weaning 27, 30 and 28 days.

29.1.6 Artificial Insemination

Title: The use of hormone preparations in pig insemination .

Author: Semenov, V.I.(1988).

Source: *Nauchnye Osnovy Razvitiya Zhivotnovodstva v BSSR*. 1988, No. 18, 47-51.

Abstract: The addition of 5 units of oxytocin or 25 or 100 mug $\text{PGF}_2\alpha$ to the semen dose shortened the time required for insemination and reduced the loss of semen from the vulva. Oxytocin and the 25 mug dose of $\text{PGF}_2\alpha$ increased the number of piglets per 100 sows by 3.9 and 2.0 resp., but the 100 mug dose of $\text{PGF}_2\alpha$ had no beneficial effect.

29.1.7 Embryo Transfer

Title: How does embryo manipulation fit into present and future pig reproduction?

Author: Polge, C.(1985).

Address: AFRC Institute of Animal Physiology, Animal Research Station, 307 Huntingdon Road, Cambridge, CB3 0JQ, UK.

Source: Control of reproduction II. **Proceedings of the Second International Symposium on Pig Reproduction**, held at Columbia, Missouri, U.S.A., May 1985. 1985, 93-100; *Journal of Reproduction and Fertility*, Supplement 33. Cambridge, UK; Journals of Reproduction and Fertility Ltd.

Abstract: Available techniques for the collection and direct transplantation of pig embryos are simple and efficient, and could be used for the expansion of new lines, for increasing selection pressure in nucleus herds, and for extracting healthy stock from a diseased source. However, the reduced viability of pig embryos during culture in vitro, and the inability as yet to preserve them by deep freezing, impose limits to the use of embryo transplantation for the export or import of potential breeding stock. The efficiency of breeding schemes could be improved by the sexing of embryos, and the possibility of producing genetically identical twins or quadruplets by micromanipulation of embryos should improve the efficiency of animal experimentation. Chimaerism may be used to rescue

embryos of a non-viable genotype, such as parthenotes or those derived by hybridization, but the greatest revolution in pig breeding may be brought about by the introduction of cloned foreign genes into eggs, and the production of transgenic animals. Eggs at an appropriate stage for microinjection may be provided in the future by techniques for the maturation and fertilization of oocytes *in vitro*.

Title: Embryo transfer in swine.

Author: Veselinovic, S.; Kosarcic, D.; Veselinovic, S.; Miljkovic, V.; Mrvos, G.; Kuzmanov, D.; Ninkov, I.; Murgaski, S.; Stancic, B.(1987).

Address: Inst. Reproduction, 21000 Novi Sad, Rumenacki put 6., Yugoslavia.

Source: 38th Annual Meeting of the European Association for Animal Production, Lisbon, Portugal, 28 September-1 October 1987. Volume 2. Commissions on cattle production, sheep and goat production, pig production and horse production. 1987, 1220-1221. Lisbon, Portugal; European Association for Animal Production.

Abstract: Embryos were transferred to 35 German Landrace gilts 4-5 days after spontaneous oestrus. 40% of recipients were pregnant 45 days later, and 8 farrowed with an av. litter size of 7.1.

Title: Manipulation of gametes and embryos in the pig.

Author: Robl, J.M.; First, N.L.

Address: Department of Meat and Animal Science, University of Wisconsin, 1675 Observatory Drive, Madison, WI 53706, USA.

Source: Control of reproduction II. **Proceedings of the Second International Symposium on Pig Reproduction**, held at Columbia, Missouri, U.S.A., May 1985. 1985, 101-114; *Journal of Reproduction and Fertility*, Supplement 33. Cambridge, UK; Journals of Reproduction and Fertility Ltd.

Abstract: Several manipulation techniques (including nuclear injections, nuclear transplantation, embryo splitting, chimaera production and sperm injection) are reviewed with special

reference to their application in the pig. The nuclear injection technique is likely to be of greatest use for gene transfer. The latter is feasible for pig embryos, but it is very inefficient. Efficiencies of various steps in the successful production of transgenic offspring, as summarised from published references, are as follows: immediate survival of embryos following injection, 60%; offspring produced from injected embryos, 15%; offspring with an integrated foreign gene, 24%; offspring expressing the integrated foreign gene, 60%. The overall efficiency is about 1%. Potential uses for nuclear transplantation are for the production of gynogenetic and androgenetic embryos, and for cloning embryos. The feasibility of producing androgenetic and gynogenetic embryos will depend on whether in the pig, as in the mouse, the paternal and maternal genomes function differently. The feasibility of cloning by nuclear transplantation will depend upon the timing of developmental events in pig embryos, and the development of methods for reprogramming nuclei. Pig embryos have been cloned by embryo splitting. Chimaera production and fertilization by sperm injection are likely to be feasible for pig embryos, but have not yet found application.

Title: A procedure for successful non-surgical embryo transfer in swine.

Author: Galvin, J. M.; Killian, D.B. and Stewart, A.N.V.(1994)

Source: *Theriogenology*, 39, 224 (Abstract).

Abstract: The cost of surgical collection and transportation is still high in pig for commercial application. They have reported successful transplantation and production of piglets following non-surgical transplantation. They have used a disposable plastic spiral catheter, which is routinely used for artificial insemination, and a bovine transfer cannula. The embryos in 10-12 ml of culture medium was expelled into the uterus. However, the pregnancy rates was low and litter size was small compared with those obtained in surgical transfer.

29.1.8 Pig Behaviour and Stress

Title: The human-animal relationship and its importance in pig production.

Author: Hemsworth, P.H.; Barnett, J.L.(1987).

Address: Animal Research Inst., Dep. Agriculture and Rural Affairs, Werribee, Vic. 3030, Australia.

Source: *Pig News and Information*. 1987, 8: 2, 133-136.

Abstract: Studies have shown that the behaviour of the handler may cause stress in pigs and adversely affect growth and especially reproductive performance.

29.1.9 Cross-breeding

Title: The use of crossbreeding to improve swine production in Canada.

Author: Fahmy, M.H.(1987).

Source: Technical Bulletin, Agriculture Canada. 1987, No. 1987-6E, iv + 19pp.

Abstract: A summary is given of a 10-year crossbreeding experiment to evaluate the productive and reproductive performance of 2-breed crosses, and carcasses of 3- and 4-breed crosses obtained from females of some the 2-breed crosses and different terminal sire breeds and crosses. The breeds involved were Yorkshire, Landrace, Lacombe, Duroc, Hampshire, Berkshire, Large Black and Tamworth. The 28 two-breed crosses were produced in an incomplete diallel mating design. Hampshire X Landrace was the best overall cross for reproduction, growth and carcass quality. Landrace X Yorkshire was the best cross for reproductive performance, followed by Large Black X Lacombe. The best 3-breed cross for market was Hampshire X (Landrace X Yorkshire), followed by Hampshire X (Duroc X Lacombe). Four-breed crosses produced by crossbred parents were generally similar in performance, or slightly inferior, to 3-breed crosses obtained from purebred boars. In general, crosses involving the coloured breeds were inferior to other crosses.

Title: Another look at F_1 crossbred sows.

Author: Kuhlers, D.L.; Jungst, S.B.(1987).

Address: Department of Animal and Dairy Science, Auburn University, AL, USA.

Source: *Pigs*. 1987, 3: 1, 12...15.

Abstract: The performance of 2-breed crossbred sows with Duroc, Landrace, Hampshire and Yorkshire inheritance, mated with Duroc, Hampshire and Yorkshire boars, was compared in gestation stalls and on unimproved pasture. Data on 844 litters from 250 sows were analyzed. Litter sizes at birth, 21 days and 56 days, and litter weights at 21 and 56 days, were lowest for Hampshire sires (10.5, 8.1 and 7.9, and 43.4 and 113.5 kg resp.) and highest for Yorkshire sires (11.3, 9.6 and 9.3, and 48.2 and 138.5 kg). Differences between sow breed types were generally small and not significant. The av. difference between 3-breed crosses and backcrosses was 0.3 for litter size at birth and 21 days, 0.4 for litter size at 56 days, and 2-3 and 10.9 kg for litter weight at 21 and 56 days. No crossbred type was consistently better than the others. After 4 litters, 78, 87 and 70% of Duroc X Landrace, Hampshire X Landrace and Yorkshire X Landrace sows resp. remained in the herd. Duroc X Landrace sows performed better on pasture, Yorkshire X Landrace sows performed better in gestation stalls, and Hampshire X Landrace sows performed equally well in the 2 systems.

29.1.10 Nutrition and Mycotoxins

Title: Mycotoxins and swine performance.

Author: Diekman, M.A.; Long, G.G.

Address: Purdue Univ., West Lafayette, IN 47907, USA.

Source: Biotechnology in the feed industry. **Proceedings of Alltech's Fourth Annual Symposium** [edited by Lyons, T.P.]. 1988, 351-362. Abstract: Moulds alone reduce the quality of cereal grains but their production of mycotoxins causes the greatest monetary loss to the animal industry by reducing growth and reproductive efficiency. This review presents general information on mould growth and the mycotoxins commonly found in grains that are fed to pigs. Growth and reproduction data are presented for the most

common mycotoxins that affect pig performance (aflatoxin, deoxynivalenol, and zearalenone). Methods to detect and quantitate mycotoxins and ways to treat or handle mouldy grain to decrease the severity of mycotoxin contamination are discussed.

29.1.11 Pig-Fish farming

Title: Livestock-Fish Integrated Systems and their roles in food supply.

Author: Chen, You-chun (1998).

Source: Proceedings of "**The 8th World Conference on Animal Production**", June 28-July 4, 1998, Seoul National University, Seoul, Korea, p-524-542.

Abstract: Pig-fish integration is quite popular and traditional. Pig slurry has high content of nitrogen. At Jinhu fishing farm, Jiangsu province, in 1.71 h of adult fish pond, manure was from 101 pigs body weight of them started from 15 kg of and finished at 95 kg. Feeding the fish by putting 67670 kg of pig slurry into pond, and 3794.6 kg of fish fry, among them 2161 kg of silver carp and bighead carp, taking 56.9% in total fish output. Result was 19946 kg of fish products and 9599 kg of body weight of pig. Income from fish was 76565.9 yuan with net income 15431.49 yuan, when from pig was 33502.5 yuan, with net income 2640.9 yuan. In comparison with single fish raising it was 35.1% more benefit obtained. The concentrates reduced in 19.9%, the cost reduced in 11.7% at each kilogram of growth weight.

29.2 AICRP on Pigs

With a view to perform research work on indigenous pigs and exotic pigs in Indian climatic conditions and environments, Indian Council of Agricultural Research launched an All India Coordinated Research Project on Pigs (AICRP on Pigs) during the IV Five Year Plan in the year 1970-71 at 4 research stations at A. N. G. Ranga Agricultural University, Tirupati; Assam Agricultural University, Khanapada; Jawahar Lal Nehru Krishi Vishwa Vidyalaya, Jabalpur; and Indian Veterinary Research Institute, Izatnagar. During 1993-94 two new centres were added

namely Kerala Agricultural University, Mannuthy and Tamil Nadu Veterinary and Animal Sciences University, Chennai.

29.2.1 Objectives

During the IV and V Five Year Plan periods, the research work was conducted only on existing exotic breeds of pigs (Large White Yorkshire at Tirupati and Jabalpur and Landrace at Khanapara and Izatnagar centres) with the following objectives:

- i) To assess various genetic parameters of economically important traits of existing exotic breeds of pigs in India with a view to utilize the same in selection index and for making a genetic advance.
- ii) To investigate the effect of protein energy ratio on production of pigs and to conduct nutritional experiments with a view only to evolve low cost and reasonable economic pig feed for different regions.
- iii) To study the occurrence of pig diseases with a view to devise suitable control measures against the same.

By the end of Fifth Plan period it was realized that in view of great economic importance of indigenous pigs to the rural population there was urgent need for improving these stocks. It was also realized that breeding technologies need to be developed to evolve a type of pig having, optimum efficiency of feed conversion in farm as well as in rural conditions. The methodology for conducting a comparative study for testing of indigenous and crossbreds could be developed through a multidisciplinary programme under All India Coordinated Research Project on Pigs. Therefore, as per decision of the Indian Council of Agricultural Research, the Technical programme of All India Coordinated Research Project on Pigs was completely remodeled in the beginning of Sixth Plan to undertake research work first on indigenous pigs and subsequently on crossbreds to be produced by crossing the indigenous gilts with boars of appropriate exotic breeds. The objectives of the remodeled technical programme were as follows:

- i) To study the performance of indigenous pigs under optimum managerial conditions.

- ii) To produce crossbreds by crossing indigenous gilts with boars of exotic breeds and to assess their performance in respect of efficiency of feed conversion, production and reproduction (Exotic breeds to be used were Largewhite Yorkshire at Tirupati and Jabalpur, Hampshire at Khanapara and Landrace at Izatnagar centres).
- iii) (a) To evolve economic pig rations with locally available feed ingredients, conventional and/or unconventional.
(b) To work-out nutrient intake under scavenging conditions and to evolve low-cost feed supplement(s) to make-up the deficiency with a view to get optimum performance from the desired type of pig.
- iv) To select animals from within half-breds with faster growth on economic ration(s) to produce superior strain of improved pigs.
- V) To study the incidence of various diseases in pigs, so as to suggest areas for undertaking research to provide optimum health cover.

29.2.2 Research Work done

Reserch work at all the six centres is being done with respect to following traits:-

1. Litter size
2. Growth
3. Efficiency of Feed Utilization
4. Carcass Characteristics
5. Mortality
6. Nutritional Studies
7. Health Cover

30. TRAINING AND DEVELOPMENT OF SKILL

Generation, transfer and the adoption of advanced technology of pig production are three important elements of pig industry. Training imparts knowledge and develops skill in farmers engaged in the pig production and pork processing.

30.1 Objectives

- ☐ To create greater awareness of and to provide new insight into the problems and possible solutions related to pig husbandry.
- ☐ For obtaining higher pig and pork production through the adoption of modern technology of breeding, hygiene, feeding and nutrition and management.
- ☐ To provide the farmers with practice oriented knowledge and skill in the field of pig production and enable them to efficiently utilize the locally available nutrient resources.

30.2 Training Institutes

Training in pig production and other livestock production and processing is a joint effort of State Agricultural Universities, Indian Council of Agricultural Research, Government of India, State Governments, Government Pig Breeding Farms, Government Bacon Factories, All India Co-ordinated Research Project on Pigs and State Departments of Animal Husbandry.

With the establishment of Agricultural Universities in India, Veterinary Colleges were conceived to be established as one of the training institute for Livestock Production and management. These colleges provided a programme of instruction and training in pig production directed towards fulfilling the needs of rural families. These institutes offers opportunity for research related to the changing needs of farmers. These institute also built up special training programme for extension workers and pig farmers.

The Indian Council of Agricultural Research is concerned with first line extension education projects and activities. It promptly demonstrates the latest pig production technologies in the farmers fields for influencing the farmers as well as the extension workers. It also studies and analyses the

socioeconomic and technological constraints which are coming as a barrier to accelerate the pig production.

30.3 Government Training Schemes

30.3.1 ICAR Training Projects

There are many projects sponsored by ICAR namely; All India Coordinated Research Project on Pigs at Izatnagar, Tirupati, Jabalpur and Guwahati, Krishi Vigyan Kendras, lab to Land programme, Tribal Area Operational Research and Socioeconomic upliftment of Scheduled Caste and backward classes.

30.3.2 TRYSEM

A Centrally Sponsored Scheme “*Training of Rural Youth for Self-Employment*” (TRYSEM) was launched by the Government of India in the Department of Rural Development on 15th August, 1979 with a objective to provide technical and entrepreneurial skills to rural youth from families below poverty line to enable them to take up self employment in Agriculture and allied business activities. The target group comprises of rural youth between the age of 18 to 35 years. This upper limit of age is relaxed to 45 years in case of widow, freed bonded laborers, freed convicts and persons displaced due to large development projects.

The identified youth are to be put through a period of training either with a training institution to provide necessary technical and entrepreneurial skills. On the successful completion of training of pig raising, they receives a combination of institutional credit under IRDP, for establishment of Piggery Unit.

30.3.3 Training Projects at State Level

State Departments of Animal Husbandry, Government Pig Breeding Farms and Bacon Factories are offering number of training courses in pig production and pork processing which are spread over a period of 15 days to 60 days. These training courses are provided free of cost.

30.3.4 Training of Technical Persons

A centrally sponsored scheme of Training of Technical

Persons and Artisans was launched by the Meat and Meat Products Division of the Ministry of Food Processing Industries in 1991-92. Under this scheme, a training cost of Rs.3000 per candidate for 25-35 trainees is provided for a training course in Piggery and Pork Processing. The course should not be of more than 2 weeks. The training cost in advance is given as grant-in-aid to the training institute after receipt of proposal. The training cost includes lodging, boarding, cost of course material, and farm and factory visit. The reimbursement of transportation cost is also given to farmers from the place of training to the place of residence. The scheduled caste and scheduled tribe candidates are also give stipend @ Rs.24/day during the entire period of training.

30.3.5 State Government Pig Breeding Farms

Most of the State Government Pig Breeding Farms are providing free training in Pig farming. The duration of training varies from 7 days to 15 days. A certificate is also awarded to trainees after successful completion of training for enabling them to raise loan from financial institutions.

30.3.6 Training under STEP

Training is given to rural women under scheme "STEP" by Ministry of Women and Child Development. The training not only covers the cost of training but also gives infrastructure cost like piglets, shed cost to start pig farming after completion of training.

30.3.7 Training in Piggery by MFPI

Government of India, Ministry of Food processing Industries is providing training cost for training in pig farming and also providing stipend to SC and ST candidates.

30.4 Training Centres

The objective of the training in pig farming is to provide technical and entrepreneurial skills to farmer or new entrepreneur to enable them to take up self employment in the field of pig farming.

30.4.1 Training facilities in India

More than 60% Government Pig Breeding Farms, Krishi

Vigyan Kendra under Indian Council of Agricultural Research (ICAR), Extension department of Veterinary colleges are involved in training in pig farming and pork processing. The duration of training varies from 7 days to 15 days. There is no “TRAINING FEE”, as Government of India, Ministry of Agriculture, Department of Animal Husbandry & Dairying, New Delhi is providing 100% grant-in-aid to these institutions for development of infrastructure for training in pig farming under centrally sponsored scheme “Assistance to States for Integrated Piggery Development”. The training is usually organized once in two months. For exact date and other boarding information, please contact the officer In-charge, Training of the institution.

30.4.2 Training facilities in Foreign Countries

The profitable pig production is not an easy task and requires considerable efforts. The socio-economic factors should be taken into consideration in harmony with existing pig farming systems.

The Innovation and Practical Training Centre Livestock (IPC Livestock) was established in August 1992 and brought together a number of practical training centres, which cover entire livestock sector and a considerable part of the livestock. In order to support and strengthen down to earth and practice oriented people in rural development in developing countries with extension and training capabilities, IPC Livestock Barneveld College annually organizes the following international courses and a training programmes:-

30.4.2.1 International Course on Pig Husbandry

IPC Livestock Barneveld College annually organizes the “International Course on PIG HUSBANDRY” (6 months).

The outline of the curriculum includes theoretical, practical subjects and Excursions to commercial pig farms, research stations, slaughter and processing plants..

- ☐ Theoretical subjects consists of genetics and breeding, economics, hygiene and disease prevention, housing, management and nutrition.
- ☐ During practical session emphasis is given on body

conformation, health care, fee stuffs, feed dosage, weight estimates, piggery equipment and systems, feeding, drinking, heating equipment, financial and technical farm administration, disinfection and hygiene, laboratory practicals.

30.4.2.2 Modern Pig Farm Management (2 weeks)

Modern Pig Farm Management is being conducted with a view to the further growth, successful competition and dynamic progress of pig farm.

- ☐ To provide the knowledge and develop the skills required to manage a commercial farm or unit in all its complexity;
- ☐ To develop the participants' ability and confidence to technically and economically analyze production units, identify bottle necks and implement procedures for possible improvements.

30.4.2.3 Artificial Insemination in Pigs (2 weeks).

The Artificial Insemination in Pigs is being conducted with following objectives:-

- ☐ To learn how to apply artificial insemination in pigs;
- ☐ To learn how to set up and manage an A.I. station for the production and distribution of boar semen.

For detailed information and submission of application please contact to the:-

IPC Livestock

Innovation and Practical Training Centre

Barneveld College P.O. Box 64

3770 AB Barneveld

The Netherlands

Tel +31342414881

Telefax +31 342 492813

E-mail: io@ipcdier.hacom.nl

30.4.2.4 International Course on Pig Husbandry

International Training Centre on Pig Husbandry, B.O. Marauoy, Lipa City, Philippines is organizing annually "International Course on Pig Husbandry". The first course was organized in 1989.

31. WOMEN PARTICIPATION IN PIGGERY

According to the Food and Agricultural Organization (FAO) of the United Nations, "Women produce 60-80 per cent of the food in most of the developing countries and are also responsible for half of the World's food production. Women play a key role in animal products production. As per 1991 Census of India, there are 407.1 million women representing 47.1 per cent of Country's total population, of these 91.40 million are in work force and 90 per cent are in informal sector with no legislative protection and with worst condition of working. The National Commission for Self Employed Woman and Women in the Informal Sector (1988) which made a factual review of women in the informal sector had suggested introduction of protective measures which would ensure guarantee of employment and income generation, minimum wages, welfare and support services, training and enhancement of skills, etc. Most of the animal husbandry activities like feeding, watering and management is done by the women.

31.1 Role of Women in Piggery Development

Among animal husbandry activities, piggery gives the highest return per unit of land used. Moreover, it is not dependent on the monsoon or irrigation and can successfully utilize drylands which might otherwise remain non-usable.

However, the average small pig farmer women lack technical training in pig management and disease control. This leads to enormous losses in terms of inadequate tapping of the genetic potential of pig, mortality and losses in marketing.

There is an urgent need to train rural women in pig farming for propagating better pig management techniques and developing new market through rural-urban linkages.

In North-eastern region, which is women dominated societies, piggery is the most important activity. In Mizoram, every house hold rears at least one to two pigs for day to day requirements. The small house hold units are fully managed by women.

31.2 Women Participation in Piggery Development

In the rural areas of developing countries, daily piggery activities are carried out to a large extent by women only.

A large proportion of women are employed in agriculture at an early stage of development in most of the Asian countries. Even in most of the South-east Asian countries where convention prevents women from working outside the home-care of pigs and small piggery units can provide opportunity to them to contribute materially to the family income and increasing the nutritional status of the family.

31.3 Women of India: Future Role in Pig Production

Women in India play a distinctive and accepted role in the process of earning a livelihood by participating in both production and marketing of animal products. Animal husbandry is still a family endeavor but the participation depends on regional and cultural norms. In tribal societies of Arunachal Pradesh, Tripura, Mizoram, Assam, Meghalaya and Manipur women workers play an important role, where "Jhumming" a form of shifting cultivation is still practiced. They often go for purchasing food as well as feed for the pigs. The women busy in piggery activity are shown in Fig. 31.3.1 and 31.3.2.

There is need to train Indian rural women, which are presently engaged in smaller pig units. After training based on improved package of practices and modern techniques, not only they can increase their pig production, but they can also increase their nutritional status of family.

31.4 Women and Pig Development Projects

A programme 'Support to Training and Employment Programme for Women (STEP)' was started in 1986 by Government of India, Department of Women and Child Development, Ministry of Human Resources Development, New Delhi. The scheme was initiated with a view to one of the measures to ensure well-being of women in the traditional informal sector and extending training for upgradation of skills and sustainable employment for women through a variety of action oriented projects which employ women in large numbers.



Fig. 31.3.1 A lady of Tripura feeding her pigs.



Fig. 31.3.2 A tribal women of Tripur with local pig.

The scheme covers 10 traditional sectors of employment including small Animal husbandry, Dairying and piggery.

Objectives

- ☐ Provide training for skill upgradation.
- ☐ Mobilizing women in small viable groups and making facilities available through training and access to credit.
- ☐ Enabling groups of women to take up employment-cum-income generation programmes of their own.
- ☐ Provide support services for further improving training and employment conditions of women.

Implementing Agencies

The scheme is being implemented through Public Sector Organizations, District Rural Development Agencies, Federations, Co-operatives and Voluntary Organizations- Non-Governmental Voluntary Organizations working in rural areas.

31.5 Credit Problems in Pig Farming

Pigs are an important source of food, energy and income for rural and tribal families. Commonly, men own the pigs and it is the task of the women to feed and care these animals. In most of the developing countries, women raise pigs and is often one of the sources of income. Pig husbandry has proved to be more important than other livestock activity in boosting the income of low-income groups.

When women's income is lacking, the whole family suffers. In many rural areas, gender-biased land tenure systems limit women's access to good financial resources. They have little or no access to credit and hence there is a need for credit facility from financial institutions for expanding pig production business to their maximum production capacity.

32. PLANNING PIGGERY PROJECTS

For a successful pig farming business, it is absolutely essential to plan in advance for various points.

32.1 Planning Piggery Projects

Points to be considered for Planning Piggery Project

Following points should be considered before taking up any piggery project.

1. Potentiality of area for piggery development

Consult the officers of State Animal Husbandry Department, DRDA and other project officers. Ascertain if pig production in the area has been generally successful.

2. Conduct Market Survey

A market survey should be conducted to find out the demand for pork and pork products and its marketing facilities.

3. Suitability of Climate

The climate should be suitable for pig farming, Obtain information on environmental temperature, proper drainage of land, soil condition etc.

4. Availability of feed or agricultural by-products

Ascertain the availability and costs and the quantity required to feed the pigs. Use agricultural by-products to reduce the feed costs without affecting the health of pigs.

5. Availability of Water

Adequate fresh, clean and soft water for drinking for pigs should be available.

6. Availability of Concentrate feed

Although pig feed is not generally available in India for pigs. But it is necessary to give supplementary concentrate feed to pigs. However, feed can be easily prepared by adding the various components of feed, but their availability should be ascertained.

7. Breed of Pigs

Consult the officials of the State Government, State Government Pig Breeding Farm Manager for existing exotic pigs available in the area.

8. Housing and equipments

Based on the capacity and type of scheme selected, fattening

or breeding cum fattening, the availability of equipments should be assured.

9. Production Performance of Suggested Breed

The production performance of the suggested breed in farm condition should be assured by consulting Pig Breeding farm Manager and other progressive farmers in that area.

10. Requirement of Labour, medicine and contingencies

The availability of trained labour, medicine and contingencies should be assured.

11. Marketing facilities

Marketing outlets like Government Bacon Factories, Private Pork Processing Plants and agents should be consulted for their requirement and rate on live weight basis.

12. Veterinary Aid

Consult the Veterinary doctor regarding availability of services for routine check up and treatment work.

13. Facilities for Breeding Pigs

If you are going to establish small piggery units or interested in crossing females with some other breed, find out the availability of boars and service charges.

14. Knowledge in Pig Farming

Acquire knowledge in pig farming by training, reading the books and magazine of pig farming. Do not forget to purchase video cassette or CD-ROM, if computer or Video cassette playing facilities are available. Watch the T.V. for "Krishi Darshan" programme on "Pig Farming" and production.

15. Training of the manager or farmer

Before taking up any piggery project, training of at least one partner or family member or manager is absolutely essential. Most of the Government Pig Breeding farms are providing free training of 1 to 2 week duration. These training are being arranged every two monthly.

16. Banking and other Financial institutions

Consult the Branch Manager, Agricultural officer of the Bank and find out the possibility of availability of credit for pig farming, along with the rate of interest.

32.2 Planning for Credit

32.2.1 Objectives of Credit

The object of credit may be following:-

- (i) Establishment of a farm for production of weaner piglets/ breeders to be sold to farmers. This may include housing, water and electric facility, road, fencing, equipment including weighing scale and ramp for loading of pigs for transport facilities, pork processing and marketing facilities, feed mill etc.
- (ii) For small farmers for purchase of pigs, housing, equipment and supplementary concentrate feed.

32.2.2 Bank Finance

Bank finance is available for following 2 types of piggery schemes -

- (1) Scheme for pig breeder, where adult pigs are financed. The farmer produces piglets and sells them to other farmers, as weaner piglets,
- (2) The small farmers purchase the weaner piglets from the pig breeders. These piglets are then reared for 4 to 6 months and after fattening they are sold in the market as fattened pigs for pork production.

33. EXTENSION FOR PIGGERY DEVELOPMENT

There is an urgent need to develop professional animal husbandry extension service to bring significant change in pig production of India. Numerous visitors to the areas can be impressed by the visible evidence of pig improvement. Pig farmers are proud of what they have achieved and are increasingly asking the extension service for more help. The extension workers are proud of their work and highly respected by those they assist.

33.1 Training and Visit System

The training and Visit system of Animal Husbandry Extension has helped to increase livestock productivity impressively in several areas. It is always difficult to isolate the factors responsible for changes in pig production. The rapid changes in pig farm output cannot be the result of an increase in adoption of modern techniques of pig farming, improved breed and breeding and management practices. But the adoption of new technology and modern equipments is not possible without extension work.

The results can be achieved rapidly and at little cost. The extension service's impact can usually be seen in the farmers' farm even before the end of first batch of fattening pigs. After 2 or 3 years, most farmers are following all or recommended practices on at least a part of their pig farm.

The emphasis should be on explaining the ideas behind the extension system, describing the methods of operation and indicating the impact. It is, of course, not the intention to suggest that extension alone can enable farmers to maximize their incomes. Good breed of pigs, nutritious and balanced feed and management of health, effective credit banks are needed. In addition, piggery development requires breeding policy depending upon the situations of the area, which provides farmers with incentives to produce. There is an imperative need on the development of an effective piggery extension service. In many areas, significant production gains can be achieved by using available resources more efficiently without significant

increases in investment. In areas where such pig production have been done, effective extension is still needed to ensure a higher standard of pig husbandry with increase use of inputs and high technology.

There is an urgent need to reform piggery extension service based on the following points:-

How it works?

How it can achieve results?

Can it convey full impact?

To understand the potential of piggery development, there is no substitute for actually visiting the piggery farms and small units, backyard piggery, seeing the systems of raising pigs, and talking with the farmers and the extension personnel.

33.2 Constraints of Extension Worker

33.2.1 Organization

It is difficult to generalize about the state of pig extension across a wide range of parts of India. We have a fairly widespread extension structure which is relatively well staffed.

In every state and Union Territory, Directorate of Animal Husbandry and Veterinary is functioning, under which the Veterinary Officer or Veterinary Assistant Surgeon is the smallest unit of the extension work. In addition to this Veterinary Officers are also functioning under "District Rural Development Agency" DRDA at district and village level for implementation of Schemes of "Ministries of Rural Areas and Employment". Every Veterinary college and Agriculture college has extension department. Indian Council of Agricultural Research has established more than 400 Krishi Vigyan Kendra for extension of Agriculture and Animal Husbandry activities.

33.2.2 Lack of Planning and targets

The extension work done is neither planned systematically nor supervised adequately. Extension workers generally do not have a detailed schedule of work.

The extension goals are generally not set, or often either too unrealistic to achieve or too vague to check and bear little relevance to the local situation. The supervisory officer

frequently have neither the means nor the intention to check the performance.

33.2.3 Dilution and Efforts

The field level extension worker is assigned multipurpose task. He often made responsible not only for all the aspects of animal husbandry, including vaccination, collection of data for livestock census, treatment of sick animals etc. As a result, the extension worker neither can perform his animal husbandry extension duties nor his other duties effectively and must resort to doing only those tasks which are most closely monitored, i.e. monthly reports and statistics.

33.2.4 Coverage and Mobility

Most extension workers have an excessively large jurisdiction. This makes it impossible to achieve the close regular contact between the extension worker and the farmers which is essential for successful extension.

33.2.5 Training

Training of extension staff is usually inadequate or outdated. The college level training, which is often too theoretical and provides little opportunity to apply in practice what have been learned. There is an urgent need to provide in-service training to extension worker specially in pig production.

33.2.6 Lack of ties with Research

There is usually no effective link with research activity done by "All-India Co-ordinated Research Project on Pigs, Veterinary colleges and State Department of Animal Husbandry and Government Pig Breeding farms. This is detrimental to the effectiveness of both the extension service and the research institutions.

There should be continuous flow of practical recommendations suited to pig farmers' needs. Without a close link with extension and feedback from the field, research becomes excessively academic and unrelated to pig farmers. The researcher should focus their work on technically optimal situations based on farmers' needs and their technical and financial capabilities.

33.2.7 Status of Extension Worker

If above factors are not taken in to consideration, it may lead to low status, low morale of the extension service. Pig farmers, who rarely see their extension workers, have little respect for them.

33.3 Basic Guidelines for Reforming Extension

The extension service is based on advice to offer to the farmers. There must be a gap between what farmers can achieve and what they are getting in their farms.

1. Unified Extension Service

After recognizing the gap, the task is to organize an effective way of closing it. There should be one governmental agency, i.e. Department of Animal Husbandry and Veterinary responsible for piggery development work, and should have full administrative control for carrying out extension systematically and effectively.

2. Exclusive Extension

Extension worker should devote all their time exclusively to professional animal husbandry extension work. They should not be assigned regulatory or administrative work.

3. Systematic Training and Visits

Once, a single line of command has been established for a extension service, the work of the service needs to be organized in a systematic time bound programme of training and visits. The duties and responsibilities should be clearly specified and closely supervised at all levels. The numbers of farms, small piggery units to be visited per week should be set at a manageable level.

4. Concentration of Efforts

The whole approach should be permeated by a concentration of efforts to achieve a clear, visible impact and continued progress. Training sessions should be concentrated on only the most important points of pig farming.

5. Immediate Success

At the initial stage it is very important to achieve an immediate impact which will give the farmers confidence in

the extension worker and the extension worker confidence in themselves. Once, this starts, the process is self-reinforcing.

6. Immutable Contact Farmers

It is almost impossible to maintain regular contact with all the pig farmers, however, the messages of the extension service should be focused mainly on selected contact farmers who will assist in spreading the new practices to most farmers in the area quickly. The contact pig farmers must be willing to try out practices recommended by the extension workers and be prepared to have other pig farmers visit their farms.

7. Best Use of Available Resources

The fundamental concept for getting highest success in extension reforms is to teach pig farmers to make best use of locally available resources. The initial stress should be on such management practices rather than on increased use of purebred exotic pigs and ready made feeds.

8. Recommendations According to Ability

The worker should usually recommend that farmers adopt these better practices at first only a small portion of their farms. This reduces the farmers' risks and hesitations and especially allows the results of the improved practices to be compared with traditional practices in farmers' own farm. This gives them confidence in the extension worker and makes them more receptive to his advice.

After improving their management practices, income of the average pig farmers will be higher and they will be financially better able to adopt more expensive breeds of pigs or concentrate feed.

9. Research

The initial message of the extension service can take advantage of the gaps between existing pig husbandry practices and the backlog of research findings which already exist but which have not yet reached to the farmers.

To remain effective, extension worker must be linked to a vigorous research program, well-tuned to the needs of the farmers.

10. Supply of Inputs and Credit

The links between extension and input of supplies and credit need to be carefully defined and developed. The extension service can be of great assistance in improving the effectiveness of the supply and credit agencies. Effective coordination should be established between extension and the supply agencies.

11. Continuous Improvement

The animal husbandry extension service requires a built-in process for continuous adaptation to changing conditions.

12. Evaluation

A self evaluation is necessary for the extension service to identify the areas needing change. Formal evaluation should be done central Ministry, Department of Animal Husbandry & Dairying for its effective planning and improvement in future Five Year Plans and Annual Plans.

33.4 Research to Solve Problems of Pig Industry

An piggery extension service cannot function for long unless there is an effective research program. In India, most of the research on piggery development is done under the administrative control of Indian Council of Agricultural Research, but it is separated from the Animal Husbandry Department. However, it is necessary to ensure close contact between the research institutions and the extension service.

The research done on pig should not be restricted to annual report and research journals, but it should be published and circulated to the Piggery Unit of the Central Government and State Government, for developing recommendations for the piggery extension service to transmit to pig farmers.

33.5 Animal Fairs, Pig Trade and Marketing

Extensive approach in piggery development can be done during Animal Fairs by organizing stalls, training, pig shows, workshops and seminars. Several modern equipment and drug manufacturing companies should be given opportunities to arrange their stalls for the benefit of pig farmers and companies.

34. AUDIO-VISUAL AIDS AND AWARDS

The audio-visual aids and awards plays an important role in stimulating pig production in the country. In India, pig farming is still in infancy stage, and there is an imperative need to increase pig production through use of media and modern multimedia creations.

34.1 Role of Audio-visual Aids

There are many pig farmers, which cannot spare their time for attending training or seminar or visit to the pig breeding farms. Audio-visual aids helps in providing opportunities to adopt latest modern techniques of pig production. These audio-visual aids can also be used during animal fairs or agricultural exhibitions like Agri-Expo etc.

34.2 Colour Slides on Pig Farming

A set of 35 mm colour slides are available at the office of Piggery India Year Book, Delhi.

34.3 Pig Encyclopedia On CD-ROM

A "Pig Encyclopedia on CD-ROM is being edited by "Dr. Chandra Shekhar Sahukar" and would be released by the end of 2000.

34.4 Pig Farming on Television

A talk on "Suar Palan" was telecasted in "Krishi Darshan" Programme on 24.7.97 by Dr. Chandra Shekhar Sahukar, Assistant Commissioner, Government of India. The main emphasis of talk was on increasing pig production through selection of improved exotic breeds, use of nutritional feeds and control of diseases.

There is an urgent need to telecast some other aspects of pig production i.e. feeding pigs for profit, Why exotic pigs?, How to start pig farming?.

34.5 Video Film on Pig Farming

A video film on pig farming in "Hindi" Produced and Directed by "**Dr. Chandra Shekhar Sahukar**" is available. It covers all the aspects of pig farming starting from introduction to selection of pigs, breeding, feeding, housing, management, reproduction and health control.

34.6 Varahashree Award 2000

“*Varahashree Award 2000*” would be presented for significant contribution on Piggery Development in India.

Varahashree Award 2000 would be presented to Indian individual/ group of individuals/ Piggery Co-operative societies/ an organization/ institutions for:-

- ☐ bringing a significant change in pig production through extension, publication work on pig farming and pig production.
- ☐ contributing significantly through production of video cassette related to pig production in any Indian language.
- ☐ contributing significant research on pig production, piggery development etc.
- ☐ evolving innovative system of housing, management technique, method of creation of disease free pig farm to boost up pig production based on locally available materials.

Eligibility for the Award

All Indian persons regardless of race, creed or sex shall be eligible for the award.

An Indian organization may also be eligible for the award having substantial outstanding work or track record of outstanding contribution in pig production.

Application

Application on prescribed format in 3 copies along with bio-data, photographs and details of the contributions, photographs, reviews or news clippings, reprint etc. should be sent through “Director of Animal Husbandry” along with his recommendations indicating the significance of Pig production work.

Last date and to Whom application should be sent?

The complete application along with the recommendation of “Director of Animal Husbandry” should be sent in an envelope superscribed “Application for Varahashree Award-2000” on or before 31.12.2000 on following address:-

Dr. Chandra Shekhar Sahukar
Assistant Commissioner (Piggery)

***Government of India, Ministry of Agriculture
Department of Animal Husbandry & Dairying
Room No. 406, B-Wing, Shastri Bhawan,
NEW DELHI-110001***

Telephone-3388911/Ext. 5033

E-mail: sahuakar@moasb.del.nic.in

Value of Award

“Varahashree Award” carries a laurel and citation.

35. FINANCING FOR PIGGERY DEVELOPMENT

Credit plays an important role in stepping up and stabilizing piggery growth in a country especially when it is associated with improved production technology. The potential of new improved technology of pig production can be fully utilized only when the demand for borrowed capital is adequately met.

The Banks are a regional development finance institutions, which were established to foster economic growth and cooperation in the region and to contribute to the socio-economic development of the livestock sector.

The role of banks in India is expected to improve the productivity of livestock, benefit farm families, increase in production of animal products and improve human nutrition. Banks enables pig farmers to increase their production and marketing. They recognizes the need to increase pig production at pace at least equal to population growth. The potential for pig production in India is promising. The banks can assist in providing finance, expertise and technology.

To generate additional employment and income to small farmers, marginal farmer and large farmer, agricultural laborer, it is essential to supply essential credit facilities for improvement of pig stock and development of other infra-structural facilities.

Funding Piggery Projects

35.1 Asian Development Bank

Asian Development Bank (ADB) is a regional development finance institutions owned by member countries from the Asia Pacific region and non-regional countries. ADB was established in 1966 to foster economic growth and cooperation in the region and to contribute to the socio-economic development efforts of the developing member countries. Nearly 30% of ADB's loans has been for agriculture and agro-industry.

It has two resources for funds to carry out its operations; ordinary capital resources which consists of subscribed capital by its member countries; and special funds resources which are contributed mainly by developed member countries. Loans from the special funds resources are made to the poorer developing

member countries on concessional terms.

35.2 National Credit Policy and Objectives

In the sphere of agricultural credit, the national policy continues to be one of providing adequate and timely credit to farmers through institutional agencies viz. Cooperatives, Commercial Banks, Regional Rural Banks to support agriculture and other activities.

The major objective of the policy is to enable farmers especially small and marginal farmers and other weaker sections to adopt modern technology and improved agricultural practices for increasing production and productivity.

Reduction in the regional imbalances and provision of adequate credit support to areas covered under various development programmes.

35.3 Role of NABARD

National Bank for Agriculture and Rural Development (NABARD) provides refinance assistance to the tune of 80% of the loan, to the banks for piggery development on reduced rate of interest i.e. 4%.

35.4 Role of Commercial Banks

Piggery can act as a subsidiary source of employment and income for small and marginal farmers and landless agricultural laborers. Medium and large farmers can also enhance their level of income by taking piggery as a supplementary enterprise. An entrepreneur may adopt piggery as his main activity, as the potential of profit offered by pig farming is very attractive. In view of the requirement of supporting all such employment generating programmes in general and raising farm production in particular banks are providing financial assistance for agricultural and allied activities viz, poultry, piggery etc., on priority basis. Public sector banks have been called upon to step up, their direct financial assistance to such sector of economy to the extent of about 18 percent of their total credit. Apart from 20 public sector banks and 29 State Co-operative Banks, 196 Regional Rural Banks are financing for such activities through the network of their branch offices. On the part of banks,

piggery credit is envisaged with twin objective of generating employment and increasing the production of pork and pork products. Financial assistance is being provided by banks on the following terms and conditions:-

35.4.1 Purpose

(a) Breeding of Pigs

For purchase of exotic breed pigs like Large or Middle White Yorkshire, Landrace (White breed),: Duroc (Brown), Large Black, Saddle Black, Hampshire (Black breed) etc. or cross-bred pigs, construction of pig pens and purchase of equipments.

(b) Rearing of Pigs

For purchase of weaner piglets (1-2 months old) for rearing/ fattening up to a period of 9-12 months for disposal in the market.

(C) Establishing Commercial Farms and Pork Processing units

Finance may also be considered for establishment of farm on commercial lines as main activity for production of piglets/ breeders. Under this, financial assistance may include housing, water and electricity facility, fencing, equipments including weighing scale, pork processing facilities etc.

(d) Purchase of Working Capital Inputs

Purchase of feed and medicines for a period not exceeding 9 months and other working capital inputs is considered for credit.

35.4.2. Eligibility

Farmers/ agricultural laborers and any individual desirous of undertaking piggery as subsidiary activity is eligible for taking loan.

The persons who are desirous to undertake the activity on commercial lines as main activity should have adequate experience in breeding/ rearing the pigs on scientific lines and adequate land area to keep the pigs. The area where the activity is prepared to be undertaken should preferably be the areas recommended by the State Government for intensive pig development or suitable for undertaking this activity.

35.4.3. Extent of Loan

(a) Pig Breeding

For Subsidiary Activity

Need based and according to the unit cost approved by the Unit Cost Committee for that area. The loan components may include purchase of boar, sows, construction of shed, purchase of equipment, feed for a period of 9-12 months, medicine and insurance cost as a composite loan.

For Main Activity

Need based according to the project report submitted by the intending borrower which should be scrutinized for its techno-economic viability and cost of items involved. A separate cash credit limit may be granted as per requirements for feeding and other expenses.

(b) Pig Rearing

Need based loan is to be given for purchase of weaned piglets, construction of pig-pens, purchase of feed up to a period of 9 months, medicine, equipment, insurance cover etc. on composite basis.

While considering the extent of loan for various items of development, the following guidelines may also be kept in mind in addition to the project report and unit size cost.

Progressive farmers who have sufficient land to produce homegrown feeds, may be financed a minimum breeding unit of 1 boar and 10 sows. Farmers who have limited capacity to produce home grown feeds may be preferred for undertaking rearing activity. The unit size/cost approved by State unit cost committee and NABARD norms may be kept in mind while processing the loan requirement,

Proximity of land for foraging purposes and availability of agricultural by-products, waste materials and home grown feeds such as tapioca, rice-bran, broken rice, sweet potato, potato, raw forest fruits such as banana, leafy vegetable, molasses distillery waste etc., may be ascertained to work out feed requirements.

The quantity of supplementary concentrate feed will

depend upon the foraging condition and the quality and quantity of agricultural by-products available in the area.

35.4.4. Margin

The margin is the contribution by the borrower from his own sources, this is essential for all types of loans, except some government scheme loans.

i) For loans up to Rs.5000/-

- a) Small farmers, agricultural laborers, and others who are covered under IRDP and other Govt. sponsored programmes and for whom subsidy is available.....Nil. .
- b) For borrowers mentioned above but to whom subsidy is not available.....5%.
- ii) For all term loans and borrowers not covered under (i) 15-25%

NOTE

- ☐ It has recently been advised that banks should not ask for margin for loans up to Rs.10,000/-.
- ☐ Where subsidy is available the same should be treated as margin and no further margin money should be stipulated for such units.
- ☐ The labor, material etc. contributed by the borrower for implementation of the piggery activity should be taken into account for calculating margin.

35.4.5. Security

Where movable assets are created

- i) For loans up to Rs.5000/- Hypothecation of assets created out of bank loan.
- ii) For loans above Rs.5000/-
 - (a) Hypothecation of assets created out of bank loan.
 - (b) Mortgage of land/third party guarantee.

Where movable assets are not created

Rs.1000/- and above.....Mortgage of land.

Note

In cases where legislation on the lines suggested by "Talwar Committee" has been passed, a simple declaration creating a charge on the land offered: as security will be sufficient. In such

cases mortgage of land may not be necessary.

RBI has recently advised banks that they should not ask collateral security for loans up to Rs.10,000/-.

35.4.6 Mode of Disbursement

It should be ensured that the pigs are of reputed breed and are purchased preferably from either Government breeding farms or private breeders of repute. The payment for the pigs, feed etc. should be made directly to the suppliers on behalf of the borrowers. However, in cases where it is not practicable, cash may be released to the borrowers in stages.

35.4.7 Interest

Medium Term Loans (Repayable in 4-5 years)

For Small Farmers - 10.00 % :

For Others - 12.50%

Short Term Loan (repayable in 1 to 2 years) or cash credit limit for working capital.

Rate of interest depending upon the quantum of such loan/limit shall be 10 to 15.5%.

35.4.8 Repayment Period.

Repayment of medium term loan is to be made in suitable installment within a period of 5 years excluding grace period of one year. Working capital can be repaid in a maximum period of 1.5 years.

35.4.9 Other Terms and Conditions

- (i) Pigs when financed for breeding should be preferably within the age group of 1 to 2 years, healthy and suitable for that area. The officials of State Animal Husbandry Department may be consulted on the breeds of pigs available in the area, usual size of piggery unit, the breeding policy recommended by the State Government etc. A certificate of age and health from the Veterinary Surgeon/Official of the State Animal Husbandry Department should be obtained.
- (ii) The animals may be got insured especially in case the financing has been done for the purpose of breeding and rearing of the pigs.
- (iii) Efforts should be made to link repayment of loan

installments with supply of the said product to some marketing agencies.

(iv) Adequate veterinary facilities should be available in the surrounding areas.

(v) Requisite space should be available for pigs.

35.4.10 Special facilities for Weaker Sections

Special rebate or other facilities are available for small farmers belonging to the weaker section of society

(i) They are provided subsidy as per the terms and condition of the scheme.

(ii) Lower interest rate as per conditions of the scheme.

(iii) Comparatively longer repayment period is allowed with an objective of allowing retention of adequate incremental income with the beneficiary.

(iv) They are required to pay lower insurance premium.

35.4.11 Procedure of lending

In case of financing under the ordinary lending scheme and the Government scheme, the intending borrower has to approach the -Branch Manager - along with his loan proposal. If the Manager is satisfied with the loan proposal, the customer will be asked to fill up loan application form supported with following documents.

(i) Loan proposal,

(ii) Project report showing the technical feasibility of the project including fixed costs, recurring cost, working capital cost, feeding, veterinary aid, insurance etc.

The proposal is considered to be economically viable if the cash outflows from a piggery unit are sufficiently more than the cash inflows. It should leave worthwhile surplus with the beneficiary as an incentive for him to undertake the piggery activity.

To encourage bank loans for development of piggery units NABARD (National Bank for Agriculture and Rural Development) provides refinance to the banks to the extent of 70% of their loans. Beside the refinance support, the bank loans are covered by the Deposit Insurance and Credit Guarantee.

Corporation (DICGC) of the Government for the purpose of guaranteeing the repayment of loans in the case of loans becoming bad and doubtful of recovery. This cover is available up to 60% of the amount in default up to a specified amount.

35.5 Role of Other Financial Institutions

Prime Minister's Rojgar Yojana (PMRY)

Under this scheme, finance up to Rs. 2.00 Lakhs is given with 10% subsidy on reduced rate of interest. Pig farming is also covered under this scheme.

National Co-operative Development Corporation (NCDC)

NCDC is providing 80% finance to piggery co-operative societies for establishment of new pig breeding farm or strengthening of existing pig breeding farms.

36. INSURANCE COVERAGE FOR PIG WELFARE

Pig insurance is an important input for encouraging the farmers to invest in high quality crossbred animals for augmenting meat production. The General Insurance Corporation of India (GIG) and the four subsidiaries Companies have extended the insurance facility for pigs. A master policy has been introduced in consultation with banks for automatic coverage of all financed animals right from the period of purchase. In order to provide effective thrust for the development of pig insurance business, the insurance companies have spread their branches network.

36.1 Role of Insurance Companies

Various schemes of pig insurance have been significantly visible in the country by the four subsidiary companies of the General Insurance Corporation of India (GIC). Apart from general schemes, there are special schemes for the beneficiaries of the Integrated Rural Development Programme (IRDP) which provide insurance cover to small piggery units purchased by the beneficiaries against the subsidy provided by the IRD agencies.

36.2 Insurance Under Government Schemes

Government agencies are trying to raise the living standard of persons falling below the poverty line. Various Government schemes have been evolved to help farmers like Integrated Rural Development Programme (IRDP), Small Farmers Developing Agency (SFDA), Marginal Farmer and Agricultural Laborer (MFAL), Special Livestock Breeding Programme (SLBP) and Drought Prone Area Programme (DPAP) Projects. The pigs subsidized under these schemes given a special low cost insurance cover at a premium rate of 2.75 percent.

36.3 Type of Coverage

Insurance covers have been devised for all indigenous, crossbred and exotic animals. To have the continuity of insurance, a long term cover over 3 years with a premium discount of 25 percent has been devised. All pigs are insured from 6 months to 3 years of age. The valuation/ sum insured

varies depending upon the breed of the pigs. Maximum sum insured for indigenous pigs is Rs.500/-. For crossbred and exotic animals as certified by Veterinary Surgeon at the time of proposal, which varies on the basis of their purpose either breeding or fattening. The rate of premium is 6% of the value of pigs but for pigs covered under Government Schemes, the rate is 2.75% per annum.

The insurance becomes of paramount importance in providing opportunity for money back guarantee to the bank in the event of death of pigs financed by them. It also opens new avenues for the farmers to receive fresh loans by which they can again purchase pigs and continue production.

37. GOVERNMENT SCHEMES FOR PIGGERY

There are number of Government schemes, which are providing financial assistance for development of piggery in the country.

37.1 Poverty Alleviation through Pig Production

Pig Production has a special role to alleviate the poverty in the rural areas. India is an agricultural country and majority of the population are rural people. Piggery can be used to make use of spare time, labor force and agricultural by- products to increase their income and provide nutritious diet for themselves. In addition, pigs also provide manure as fertilizer for crop production. The pig production programme will not only improve the availability of the pork, but also help in improving the economic conditions of the society. The pig possesses higher prolificacy, shorter generation interval, faster growth and better feed conversion efficiency. Piggery is one of the activity under PMRY scheme and can help the poor people to select this activity for alleviating poverty.

In India, poverty is measured by the expenditure required to acquire the minimum calorie needs, calculated at 2400 calories/head/day for the rural areas and 2100 calories/head/day for urban areas. Planning Commission determined the poverty line for rural areas at 1991-92 prices as Rs.10060/annum/household. Thus all below the poverty line are at risk of hunger and its consequences. Man, woman and child has the inalienable right to be free from hunger and malnutrition. Hunger depletes strength and makes people vulnerable to infectious diseases. In India, more than 360 million people are at the risk of hunger. The land resources are limited and size of the land is decreasing due to the division in the family. Though the production in agriculture has increased/ hectare but the total family income in rural areas has been decreased.

Animal Husbandry specially Pig Production has a special role to alleviate the poverty in the rural areas. India is an agricultural country and majority of the population are rural people. Piggery can be used to make use of spare time, labor

force and agricultural by-products to increase their income and provide nutritious diet for themselves. In addition, pigs also provide manure as fertilizer for crop production.

Indigenous or desi pig production plays an important role in the pig production system in India. These small units are unorganized and the herd size is very small. Though the performance of desi pigs is very low, but the profit is still high because of lower or nil cost of inputs.

In the rural areas pigs are let loose within the village and looked after by women or small children. In the towns, piglets are weaned by 4 weeks of age and left in various sectors of the town. The only investment the owner makes being to count the number left alive every Sunday morning when he is not otherwise occupied. He collects the pigs at about 12 months of age, when they weigh 30-40 kg, they are then slaughtered and sold as fresh pork only.

There are about 12 million pigs in the country largely maintained by the economically and socially backward sections of the society. The pig production programme will not only improve the availability of the pork, but also help in improving the economic conditions of the society. The pig possesses higher prolificacy, shorter generation interval, faster growth and better feed conversion efficiency. The pork is soft, juicy and delicious and tasty. It plays a vital role in meat production at low cost. "AMUL" pattern of pig co-operative marketing of pork and pork products will serve as a powerful tool in developing this industry. Stimulation of this industry can be to great help to solve the food problem, utilization of agricultural by-products, diversify agricultural production and employ available man-power resources. Pigs are the valuable source of high quality protein at a low cost, and this industry gives high return with a low investment.

37.2 Traditional pig rearing system

The traditional pig keepers belonging to socio-economically backward class of the society are compelled to follow old and primitive method of pig raising. Under

scavenging system pigs are allowed to roam free and fed on garbage materials. Though it results in poor growth, low litter size, low feed conversion efficiency and poor quality of pork and pork products, but it does not require effort in management and practically no expenditure on feed.

37.3 Government Strategy for Piggery Development

In India there are 158 pig breeding farms are in Government sector in different parts of the country, catering the need of the 8 bacon factories in Government sector and 150 pig processing units in private sector. These government pig breeding farms are maintaining the exotic stock of Large White Yorkshire, Middle White Yorkshire, Berkshire, Hampshire, Landrace, Tamworth etc.

The government strategy in piggery development work is to use improved exotic pigs for grading up the indigenous stock. The pig breeding farms multiplies and distributes the breeding stock at subsidized rate for improvement of pigs.

37.4 Government of India, Ministry of Agriculture

A Centrally sponsored Scheme "Assistance to States for Integrated Piggery Development" was started during 1991-92 to assist State Government Pig Breeding Farm by way of 100% Grant-in-aid for development of infrastructural facilities like Improvement and strengthening of herd through purchase of exotic pigs and their transport cost; alteration and remodeling, renovation, additional housing for pigs, stores, office ; land development, leveling, fencing and watering facilities; and for purchase of equipment, feeding utensils and necessary furniture etc., with a total grant of Rs. 6.00 lakhs per farm. During 1995-96, the EFC memo was revised on 7th December, 1995 to include Pig Breeding Farms under

1. State Government, 2. Agricultural Universities/ Veterinary Colleges, 3. Krishi Vigyan Kendra under ICAR.

Objectives of the Scheme

1. To increase availability of improved/exotic breeding stock for inter-farm purchase and distribution to public / farmers.
2. To utilize the available infrastructure facilities more gainfully

trough strengthening farms.

3. To increase the returns of pig farming.
4. To increase the availability of pork trough increased pig production.
5. To improve the nutritional status of poorer section of people through pig meat consumption.
6. To impart training facilities to farmers on pig production.
7. To provide better marketing support through piggery co-operatives.

Importance of Scheme

1. Pig farming has a special significant role in improving the socio-economic conditions of people of North-Eastern region. Pig husbandry is very important, a pig meat is a staple food in these states and nearly every household rears pig for their day to day requirements.
2. Pig farming is a very important activity of poorer class of people and women.

Amount of Assistance

The pattern of financial assistance for one pig breeding farm is as follows:-

Item	Cost (Rs. in lakhs)	
	New Farm	Existing farm
1. Improvement & Strengthening of herd through import and transport cost	6.00	14.00
2. Alteration, remodeling, renovation, additional housing, stores, office etc.	6.00	3.00
3. Land Development, leveling, fencing and watering facilities etc.	2.00	2.00
4. Purchase of equipment, feeding utensils and necessary furniture etc.	3.00	1.00
5. Provision for training facilities	5.00	2.00
6. Assistance for Co-operative infrastructure and Marketing facilities	8.00	8.00
Total	30.00	30.00

To Whom proposal should be sent:-

The complete proposal with recommendations of the state Government, Department of Animal Husbandry, should be sent

to Assistant Commissioner (Piggery), Government of India, Ministry of Agriculture, Department of Animal Husbandry, Room No. 406, B-Wing, Shastri Bhawan, New Delhi.

37.5 I.R.D.P.

Intensive Rural Development Project (IRDP) is a beneficiary oriented programme. Its objective is to enable selected families in rural areas to cross the poverty line. The objective of the programme is achieved by providing productive assets and inputs to the target group. The assets for the pig raising are financial assistance for purchase of pigs, construction of pig sty etc. in the shape of subsidy by the Government and term credit advanced by the financial institution.

Target Group

The target group consists of small and marginal farmers, agricultural laborers and rural artisans etc. whose annual family income is below the "cut-off" line, i.e. Rs.4800/-.

1. Small Farmer

A cultivator with a land holding of 2 hectares or below is a small farmer.

2. Marginal Farmer

A person with a land holding of 1 hectare or below is a marginal farmer.

3. Agricultural Laborers

A person without any land other than homesite and deriving more than 50 % of his income from agricultural wages is an agricultural laborer.

Safeguards for Certain Sections

At least 50 % of the assisted families are drawn from the Scheduled castes and scheduled tribes. At least 40 % of the total beneficiaries are women. At least 3 % of the beneficiaries chosen are from the category of physically handicapped persons.

Selection of Projects

The selection of projects is done on the choice of the selected family and the availability of backward and forward linkages for the successful operation of the scheme.

Eligible Activities under the Programme

Pig raising is one of the eligible activity under the programme, as it is an economically viable project.

Subsidy Pattern

For individual family, small farmers are eligible for a subsidy of 25 %, Marginal farmers, agricultural laborers, non-agricultural laborers and rural artisans-33.33 % subject to a ceiling of Rs.3000 per family in non DPAP/DDP areas and Rs. 4000 in DPAP/DDP areas.

However, scheduled caste, scheduled tribe families and physically handicapped persons are eligible for 50 % subsidy, subject to a ceiling of Rs. 5000 per family in all rural areas.

Subsidy Credit Linkages

The subsidy is linked with the credit from the financial institutions like banks, and given in kind or cash.

Norms of Lending

The loan amount is equal to the total project cost minus the amount of subsidy admissible to the beneficiary.

The interest rate is 12 % per annum for the animal husbandry sector.

Repayment of Loans

Loans under IRDP are treated as medium term loans. The repayment of the loan varies from 3 to 5 years.

37.6 S.T.E.P.

A programme '*Support to Training and Employment Programme for Women* (STEP)" was started in 1986 by Government of India, Department of Women and Child Development, Ministry of Human Resources Development, New Delhi.

- ☐ The scheme was initiated with a view to one of the measures to ensure well-being of women in the traditional informal sector and extending training for upgradation of skills and sustainable employment for women through a variety of action oriented projects which employ women in large numbers.
- ☐ The scheme covers 10 traditional sectors of employment including small Animal husbandry, Dairying and piggery.

- Under this scheme financial assistance is given for training and creation of infrastructure i.e. shed, purchase of pigs and equipments in a group of women beneficiaries, i.e. 500-600 women.

37.7 D.W.C.R.A.

The Development of Women and Children in Rural Areas (DWCRA) is a sub-scheme of the IRDP, and is specially designed to provide support for poor women in rural areas. The aim of the DWCRA is to improve the status of the rural poor women. The main strategy under the programme is to improve the access of poor women to employment, skill training, credit and other support services. At the same time the focus is also conversing other services, like family welfare, health, nutrition and education to the target groups benefit. This programme also emphasizes child care as an essential element for freeing poor women to take up employment outside their homes. The DWCRA programme provides inputs for taking up income generation activities on group basis.

COVERAGE UNDER DWCRA

The DWCRA was introduced on a pilot basis in 50 districts in 1982-83 with the UNICEF assistance. The scheme was in operation in 290 districts during 1992-93. Fifty new districts are being added every year to cover all the districts by the end of the VIII Plan (1994-95).

CRITERIA FOR SELECTION OF NEW DISTRICTS

The new DWCRA districts are approved by the Govt. of India on the basis of the State Governments' recommendations. The criteria for selection of a new district is its backwardness, low female literacy rate, high mortality etc. The State Governments take up preparatory work as soon as they recommend the names of new districts for the DWCRA including provision of funds in the State budget for release of the matching State share of the revolving fund, appointment of staff and their training, preparation of project profiles of viable activities to be taken up by women's groups, establishing linkages with other technical agencies for marketing

arrangements, and other social development programmes for health, education and sanitation services.

PROGRAMME STRATEGY

In this scheme, instead of the family being the focus, groups of poor women are assisted through a package including loan, subsidy as per entitlement under the IRDP, skill upgradation under the TRYSEM and group revolving fund of Rs. 15000. The DWCRA group normally consists of 10-15 women.

FUNDING PATTERN

The DWCRA programme is also differently funded. Subsidy and loan is provided as in the IRDP. The DWCRA sheds multipurpose centres are funded under the Jawahar Rojgar Yojana (JRY). In addition to the these loan and subsidy to individual members, each group of women under the DWCRA is given a lump sum grant of Rs. 15000 as revolving fund. The Rs.15000 is equally shared among the Government of India, the State Government and the UNICEF. In the case of Union Territories the Central Government contributes Rs. 10000 and the UNICEF Rs. 5000.

The revolving fund is for purchase of raw material and marketing. An honorarium of Rs. 50 per month for one year is admissible to the group organizer. Infrastructure support for income generating and other group activities like child care expenditure are used from the revolving fund.

SELECTION OF ACTIVITIES

Piggery is one of the economic activities under DWCRA. The other animal husbandry activities under this scheme are Poultry, Goat rearing, Duckery and Dairy.

37.8 Special Livestock Breeding Programme (SLBP)

The Special Livestock Breeding Programme (SLBP) was started with two objectives of involving small and marginal farmers and agricultural laborers in livestock production, and to generate additional employment and income. Production of improved stock under the scheme will also help augment availability of good quality animals to IRDP beneficiaries. The scheme was started by the Ministry of Agriculture, Government

of India and now it has been transferred to State Governments.

TARGET GROUP

The target group covered under SLBP programme are small farmers, marginal farmers and agricultural laborers, not covered under IRDP. The target group consist of at least 30 % beneficiaries from Scheduled Castes and Scheduled Tribes and 30 % amongst the women farmers.

COMPONENTS

Piggery is one of the important activities under this scheme. A unit of 3-5 sows and one boar for every five units of 3 sows is subsidized to make them economically viable and capable of generating income.

FARMERS' INDUCTION

In order to make the SLBP scheme more effective, the important aspects of farmers' induction and training have been introduced. It is an essential element of programme and each selected beneficiary is given appropriate training.

SUBSIDY

The subsidy ceiling for a single beneficiary is Rs.3000 (Rs. 5000 in case of tribal and Scheduled caste). The subsidy for providing insurance premium for livestock is also granted under this scheme. The remaining amount of the project is sanctioned as medium term loan from banks. The subsidy for the cost of feed for boar for 3 years is also provided to increase the number of cross-bred animals.

37.9 Prime Minister's Rojgar Yojana

The Prime Minister's Rojgar Yojana (PMRY) has been designed to provide employment to more than a million persons by setting up of 7 lakhs micro-enterprises by the educated unemployed youth. It relates to the setting up of the self employment ventures through industry, service and business routes.

Eligibility

Any unemployed educated person living in any part of the Country rural or urban fulfilling the following conditions:

1. Age Between 18 to 35 years

2. Qualification Matric or IIT passed or Govt. sponsored technical course for a minimum duration of 6 months.
3. Residency: Permanent resident of the area for at least 3 years
4. Family income up to Rs. 24000 per annum.
5. Should not be defaulter to any Nationalized bank/financial institution/cooperative bank.

Activities Covered

Entrepreneurs can take loan for any enterprise, industry, service or business including piggery.

Project cost

Projects up to Rs. 2.00 lakhs are covered under the scheme in case of individuals. If two or more eligible persons join together in a partnership, the project with higher costs would also be covered provided share of each person in the project cost is Rs. 2.0 lakhs or less. In such cases there is no ceiling.

Margin Money

Entrepreneur is required to contribute 5 % of the project cost as margin money in cash. Balance 95% would be sanctioned as loan by the Bank at the rates of interest applicable to such loans under RBI guidelines.

Collateral Guarantee

The loans would not require any collateral guarantee. Only assets created under the scheme would be hypothecated to the Bank.

Subsidy

Government of India would provide subsidy at the rate of 15 % of the project cost subject to a ceiling of Rs. 7500 per entrepreneur.

In case of more than one entrepreneur join together and set up a project under partnership, subsidy would be calculated for each partner separately, at the rate of 15 % of his share in the project cost, limited to Rs. 7500 per partner.

Repayment Schedule

Repayment schedule would range from 3 to 7 years after an initial moratorium of 6 to 18 months.

Implementing Agencies

The State/UT Governments may select and declare on agency as implementing agency out of the district industries centre /Directorate of Industries/ District Urban Development Agency in four Metropolitan cities of Delhi, Mumbai, Calcutta and Chennai.

Training

Scheme envisages compulsory training for Entrepreneur for a period of four weeks after the loan is sanctioned. Rs. 2000 per beneficiary has been earmarked for training and other Entrepreneurial assistance like preparation of project profiles, market surveys, concurrent evaluation, monitoring etc. Rs. 1500 per beneficiary will be released to the States/UTs towards training, conducting market surveys, preparation of project profiles and Rs/500 will be retained by Government of India for concurrent evaluation and monitoring.

37.10 Scheme for Assistance from NCDC

National Cooperative Development Corporation (NCDC) is extending credit facilities at reduced rate of interest to piggery development co-operative societies, either for establishment of new pig breeding farm or strengthening of existing piggery farm under co-operative establishment.

38. CONSTRAINTS AND STRATEGIES

38.1 Constraints of Pig Production

Non-availability of Quality exotic pigs

In India, more than 158 Government pig breeding farms are engaged in pig breeding and distribution to farmers, but their production capacity of piglets is insufficient to meet the current demand.

Non-availability of Compound feed

The compound feed at competitive rates is not available for various stages of pigs i.e. piglets, growers, fattener, sows, pregnant sows and boar.

Private Pig Breeding Farm

In India, there is acute shortage of good private pig breeding farms, which can supply good quality exotic piglets to farmers.

Vaccine Availability

Some places, swine fever and foot and mouth disease vaccine is not regularly available.

Credit Facilities

Some Banks are hesitating for financing piggery activity, as they think that it is not the profitable activity.

Training Facilities

Training facilities are not available at all Government Pig Breeding Farms and Krishi Vigyan Kendra. There is an urgent need to extend the training facilities at all these centres.

Proper Marketing Facilities

In India, very little marketing facilities are available on legal basis, thus most of the pigs are being slaughtered and sold as fresh pork. Most of the Government bacon factories, which were established during various Five Year plans, are either running below installed capacity or closed.

38.2 Suitable Strategies for improving Pig Production

These above constraints can be easily removed by importation of exotic pigs from foreign countries, as the stock at Government Pig Breeding farms has been deteriorated due to inbreeding. Training infrastructure facilities should be strengthened at Government Pig Breeding Farms and Krishi

Vigyan Kendra for training of pig farming. At least one training should be arranged in two months for a batch of 20-25 farmers of 1-2 week duration. The compound feed factories should come forward to make available piggery balanced feed for all stages of pigs. There is an urgent need to restructure Pork Processing Units/ bacon factories for marketing of pigs. They should pay remunerative price to the pig producers, for the development of this activity in the country. Vaccine producing and supplying companies should ensure, that swine fever and foot and mouth vaccine is available through out the country to solve the disease problems in pigs.

39. SUSTAINABLE PIG PRODUCTION

Sustainable pig production is dependent on the choice and application of appropriate practical technologies. The scale and extent of the success of the latter is influenced by the size of the pig farm. For adopting sustainable pig production, more development effort is necessary to demonstrate their potential value and impact. Such efforts need necessarily to consider the nature of the mixed farm operation, pig-fish farming, crop-pig interactions, viability of the system, efficiency in the use of meager resources and opportunities for demonstrating impact.

39.1 Why Sustainable Pig Production

Sustainable pig production is essential for maximizing profits at low input.

39.2 Information needed by farmers and advisers

- Choice of breeds
- Choice of feeds
- Extent of availability and seasonal supply
- Nutritive value of feed and by-products
- Detailed information of low cost housing and other infrastructural inputs
- Prediction of change during production
- Capacity to meet pig production target
- Capacity of filling any nutritional gap
- Strategic supplementation
- On pig performance of desi and exotic pigs
- On sustainable production of basal feed resource
- Systems of raising
- System of feeding
- Level and type of production
- Realistic production targets.

39.3 Delivering information to pig farmers

- Methodology, a balance between basic and applied research
- Linkage between disciplines and institutions
- Demonstration of economic benefit
- Large-scale on farm testing
- in situ* utilization

farmer participation and

definition of a model for feed resource developments

Several criteria need to be considered on-farm work and these include inter alia the production objective, the treatments involved, the precise methodologies to be used, measurements to be undertaken, type and value of input used and the outputs derived from the experiment, extent of farmer participation, issues related to the economic analysis of the results and marketing.

39.4 Other Practical Technologies

In small farm systems, farmers can resort to several useful and practical technologies. Soaking can be used to increase the utilization of sorghum grains fed to native pigs in El Salvador, where the pig production is mainly a family enterprise and over 80% are indigenous breeds. Sorghum is soaked for 72 hours to allow fermentation and to increase digestibility. The results gave feed conversion efficiencies of 4.6, 5.0 and 4.2 for these treatments compared with 7.6 for the control group fed only unfermented sorghum. The cassava leaves which contains hydrocyanic acid and toxic to pigs. Sun drying freshly harvested leaves and root peelings reduces hydrocyanic acid levels through the interaction with sunlight. The cyanogen is released as gas.

40. TECHNO-ECONOMIC FEASIBILITY REPORT

Pork is a very important source of animal protein for the human diet. It is a nutritionally balanced and palatable food. Pig is one of the most efficient food converting animals among the domesticated live-stock. It is the only litter bearing animal among meat producing livestock, having the shortest generation interval and feed-conversion efficiency. The demand of pork is being increased day by day, and the present strength of the piggery farms in the surrounding area is not in a position to meet the growing demand of pork and pork products. The rearing of pigs involves a nominal investment and can be practiced as a cottage industry.

Any person can avail loan for piggery farm, but he has to submit Techno-economic feasibility report to the bank. Two model project reports are being given, however, the parameters may vary depending upon the place and availability of by-products and importance of piggery in area and cost of infrastructure facilities like piglets, availability of feed etc.

40.1 Points for Techno-economic Feasibility report

Objective of the Project

The main objective of the project is to establish a small piggery unit. Pigs can attain a live-body weight of 70-90 kg in 6 to 8 months. The weaner pigs of 2 months age will be purchased and reared for 6-8 months. The live pigs would be sold to the Government Bacon Factory/ private pork processors.

Location of the Pig Farm

The unit can be established on a small piece of land but it should be away from the residential area to avoid the odour of pigs. Any area is suitable for piggery development and it is the most profitable business based on Animal Husbandry.

Suitability of the Climate

The tropical climate is suitable for maintaining pigs in optimum health and production. The soil should be well drained and there should not be water logging conditions.

Availability of Water

The underground water is adequately available at a depth

of 50 ft. and is of good quality. The water should be clean, palatable and soft and suitable for drinking purpose. It is advised to install a tubewell and submersible pump. The electricity is easily available near the farm.

Availability of Feed and By-products

The concentrate feed and agricultural by-products like hotel and kitchen waste, rice bran, broken rice, tubers such as sweet potato, potato, raw forest fruits such as banana, leafy vegetables, molasses, distillery waste, pulse chunies and wheat bran are freely at competitive rates in the nearby market and can be safely fed to pigs.

Housing and Equipments

The building material for housing of pigs is available in the surrounding area and can be constructed as per the layout and expenditure included in the project. The provision has been made for the construction of grower and fatterer house. The construction of houses will be pucca with asbestos roofing. Provision has also made for the construction of false roofing to prevent pigs from excessive heat during summer. The ceiling fans and exhaust fans can be installed for maximizing the feed conversion efficiency of the pigs. All equipments used for feeding and watering are available in the market.

Availability of Animals

The Large White Yorkshire, Landrace and Hampshire pigs are suitable for pig farming. The cross-bred pigs are also available at Government Pig Breeding Farms at subsidized rates.

Veterinary Facilities

The veterinary facilities are easily available. In addition to this private veterinary consultants are also available at reasonable fees. For the purpose of vaccination, deworming and routinely check up of the health of the animals a veterinarian should visit the farm at regular intervals.

Availability of Infra-structural facilities

The labor and other infrastructural facilities are easily available at village area.

The facilities are available for collection, transport and

slaughter, processing and marketing of pork and pork products. In addition to this Government Bacon Factories are also purchasing fattener at a good price. A private pork processor is also offering attractive price for fatteners. The pigs can be sold on live-weight basis.

The interested persons can obtain training at Government Pig Breeding Farm, Krishi Vigyan Kendra, Veterinary Colleges and other training Institutes at free of cost.

Total Project Cost and loan amount

On the basis of the feasibility report, the total non-recurring cost of the project, the working cost of the capital for the first batch of pigs, the total amount of the capital requirement of the project is shown in the report. The entrepreneur can only contribute the 25% of the total cost of the investment which includes the amount of subsidy.

The capital requirement in shape of loan amounts to 75% of the total project cost and working capital for the first batch of the pigs, is available at all Nationalized Banks and Rural Banks.

Economics, repayment and Security

Based on the techno-feasibility report, the project would earn the net profit from the first year. The amount of loan and interest can be repaid by me in equal monthly installments within a period of 5 years, with a repayment holiday of 6 months. The amount of loan and interest depends on cash flow unit size.

The market value of the land and other immovable assets of which the farm is to be established which could be mortgaged to the Bank along with the structure thereon. The houses and pigs could also be insured, and the policies can also be mortgaged.

40.2 Model Feasibility report for Fattener Scheme

Capacity of Unit	50
Type of Breed-	Graded/Crossbred

ASSUMPTIONS

Cost of feed (Rs./kg)	5
Weight of the weaned piglet(2 Months)	16
Rate of weaned Piglets (Rs./kg)	35
Average price of one weaned piglet (Rs.)	560
Feed conversion efficiency	4
Sale price of Pigs on Live weight basis (Rs./kg)	35
Average Live weight of one Pig (kg)	70
Average Sale price of 1 pig on Liveweight (Rs.)	2450
Bank Loan (%)	75
Rate of Interest (Rs.%)	12
Insurance(%)	4
Quantity of Feed/pig (kg.)	200
Construction cost (Rs./sq.feet)	50
Rearing cycle(Months)	6
Rearing cycle/year	2

FIXED CAPITAL INVESTMENTS

Land	Free
Construction of pens (10X8)Ft. with run of (10X7)Ft.	
No. of pen	5
Total construction area of pen (Sqare feet)	750
Construction of Office and Feed Store room (Sq. ft)	500
TOTAL CONSTRUCTION AREA (Sq.ft)	1250
Cost of construction (Rs./kg)	50
TOTAL CONSTRUCTION COST (Rs.)	62500
Cost of Equipment (Rs./adult unit)	50
TOTAL COST OF EQUIPMENT (Rs.)	2500
TOTAL INVESTMENT ON FIXED CAPITAL	65000

RECURRING EXPENDITURE (Per Cycle of 6 Months)

Purchase of weaned piglets of 2 months age (nos.)	50
Cost of weaned piglets (Rs.)	560
TOTAL PURCHASE PRICE (Rs.)	28000
Cost of Feed (Rs./kg.)	5
Total requirement of feed (kg.)	10000
TOTAL COST OF THE FEED (Rs.)	50000
Insurance and Veterinary aid @Rs.100/unit size	5000
Number of labours	1
Cost of One Labour (Rs./ 6 months)	9000
TOTAL LABOUR COST (Rs.)	9000
REPAIR AND MAINTENANCE (Rs.10/unit/cycle)	500
Total recurring expenditure for 6 months	92500
TOTAL RECURRING EXPENDITURE	185000
TOTAL PROJECT COST(Rs.)	157500
TOTAL Farmer,s investment (Rs.) (25 %)	39375
BANK LOAN (Rs.) (75 %)	118125

INCOME

Total live pigs available (mortality 5 %) after 12months	95
Live weight per pig	70
Total live weight of the pigs	6650
Sale price of pork on live wt. basis	232750
Sale of manure @Rs.10/pig	1000
TOTAL INCOME	233750
TOTAL SURPLUS (Rs.)	48750

CASH FLOW STATEMENT

Year	I Year	IIYear	IIIYear	IVYear	VYear	VIYear
Gross Surplus (Rs.)	48750	48750	48750	48750	48750	48750
Loan outstanding	118125	94500	70875	42250	23625	0
Interest	14175	11340	8505	5670	2835	0
Loan installment	23625	23625	23625	23625	23625	0
Total Loan & Intt.	37800	34965	32130	29295	26460	0
NET SURPLUS	10950	13785	16620	19455	22290	48750

40.3 Model Report for Breeding cum Fattening farm

Capacity of the farm

Number of the Sows	10
Number of Boar	1
Total Number of Adult pigs	11
Type of Breed-	Graded/Crossbred

ASSUMPTIONS

Cost of feed (Rs./kg)	5
Weight of the weaned piglet(2 Months)	16
Average price of one boar/gilt (Rs.)	1050
Feed conversion efficiency	4
Sale price of Pigs on Live weight basis (Rs./kg)	35
Average Live weight of one Pig (kg)	70
Average Sale price of 1 pig on Liveweight (Rs.)	2450
Bank Loan (%)	75
Rate of Interest (Rs.%)	12
Insurance(%)	4
Quantity of Feed/pig (kg.)	250
Construction cost (Rs./sq.feet)	50
Rearing cycle/year	1.5

FIXED CAPITAL INVESTMENT

Land	FREE	
Construction of Pens	No.	Area Sq. ft
Boar pen (10X8) ft with run of(10X7) ft	1	150
Farrowing pens (10X8) ft with run (10X7) ft.	4	600
Dry Sow pens (10X8) ft. with run (10X7) ft.	2	300
Weaner's pens (20X8) ft.	4	640
Lactating sows pen(20X8) feet	4	640
Office cum store room (25X15) ft.	1	375
Total Construction Area (Square feet)		2705
Cost of Construction (Rs./sq. feet)		50
TOTAL CONSTRUCTION COST (Rs.)		135250

COST OF EQUIPMENTS (Rs./adult pig unit)	200
TOTAL COST OF EQUIPMENTS (Rs.)	2200
TOTAL FIXED CAPITAL INVESTMENT (Rs.)	137450

RECURRING EXPENDITURE

Purchase of Foundation Stock	No.	Total Wt.	Rate	Cost
Purchase of Gilts weighing 30 kg.	10	300	35	10500
Purchase of Boars weighing 30 kg.	1	30	35	1050
TOTAL Purchase price for stock (Rs.)				11550

EXPENDITURE ON FEED (First year)

	No.	Daily Req.	Days	Total (kg)
Feed for Breeding Stock till puberty	11	1	120	1320
Feed for sows during pregnancy	10	2	185	3700
Feed for sows after farrowing	10	3.25	60	1950
Feed for Boars	1	3	245	735
Feed for creepers	90	0.25	40	900
Feed for weaned piglets	90	0.4	20	720
Feed for fattener pig kg	90	1.2	180	19440

TOTAL FEED REQUIREMENT	28765
Rate of feed (Rs./kg)	5
TOTAL EXPEN. ON FEED (Rs.)	143835

EXPENDITURE ON FEED (II Year onwards)

	No.	Daily Req.	Days	Total (kg)
Feed for sows during pregnancy	10	2	305	6100
Feed for sows after farrowing	10	3.25	60	1950
Feed for Boars	1	3	365	1095
Feed for creepers	150	0.25	40	1500
Feed for weaned piglets	150	0.4	20	1200
Feed for fatteners	150	1.2	180	32400

TOTAL FEED REQUIREMENT	44245
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Rate of feed (Rs./kg)	5
Total expenditure on feed (Rs.)	221225

TOTAL EXPENDITURE ON INSURANCE (4%)	880
TOTAL LABOUR REQUIREMENT (No.)	2
Labour Rate (Rs./annum)	12000
TOTAL EXPENDITURE ON LABOUR (Rs.)	24000
Expenditure on Veterinary Care (Rs./adult units)	100
EXPENDITURE ON VETERINARY CARE (Rs.)	1100
Miscellaneous expenditure (Rs/adult unit)	100
MISCELLANEOUS EXPENDITURE	1100

TOTAL RECURRING EXPENDITURE (Rs.) (I Year)
170905

TOTAL RECURRING EXPENDITURE (II Year onwards)
248305

INCOME FOR THE FIRST YEAR OF THE PROJECT

Live weight of pigs	70
Sale of pigs	90
Rate/kg	35
Total income from sale	220500
Income from the Sale of manure (Rs/adult unit)	200
TOTAL SALE OF MANURE (Rs.)	2200
TOTAL INCOME (Rs.)	222700
TOTAL FIXED CAPITAL INVESTMENT	137450
COST OF FOUNDATION STOCK	11550

TOTAL PROJECT COST (Rs.)
308355

TOTAL LOAN (Rs.)
231266.2
MARGIN (25%)
77088.75
77088.75

INCOME FROM II YEAR ONWARDS

Weight of pig kg.	70
Sale of fattener pigs of 8 months age	150
Sale of fattener pigs Rate /kg	35
TOTAL INCOME FROM SALE OF pigs (Rs.)	367500
Income from the Sale of manure (Rs/adult unit)	200
TOTAL INCOME FROM SALE OF MANURE (Rs.)	2200

TOTAL INCOME (II YEAR ONWARDS) 369700

CASH FLOW STATEMENT

Year	I Year	IIYear	IIIYear	IVYear	VYear	VIYear
Gross Surplus (Rs.)	51795	121395	121395	121395	121395	121395
Loan outstanding	231266	259018	207215	155411	103607	51804
Interest	27752	31082	24866	18649	12433	6216
Loan installment	0	51804	51804	51804	51804	51804
Total Loan & Intt.	0	82286	76669	70453	64237	58020
NET SURPLUS	51795	38509	44726	50942	57158	63375

41. REPRODUCTION IN PIGS

Reproduction is one of the important point in any pig farm. Pig is a very fertile species and profit lies in achieving full reproductive potential of the animals.

41.1 Reproductive Physiology of Pigs

41.1.1 Genital Organs of the Boar

The testicles are very large and are regularly elliptical in contour. The scrotum is situated a short distance from anus and not so sharply defined as in other domestic animals. Testicles are comparatively soft in texture. The epididymis is closely attached to the testicle. The spermatic cord is very long, 20-25 cm. in a boar of medium size. The ductus deferens is closely attached by the tunica vaginalis. The vesicula seminalis are exceedingly large, and extend into the abdominal cavity. The prostate consists of two parts, the body is 2.5 inch wide and overlies the neck of the bladder and the urethra at their junction. The bulbo-urethral glands are very large and dense and somewhat cylindrical and lie on either side of and upon the posterior two-thirds of the pelvic urethra. The penis resembles that of ox but sigmoid flexure is prescrotal. The anterior part has no glans, and spirally twisted, especially in erection. The penis in an adult boar measures about 18 to 20 inches in length. The prepuce has a narrow orifice which is surrounded by stiff hairs. The urethra has a very long pelvic part, which is covered by a thick urethral muscle. The genital organs of the boar are shown in Fig. 41.1.1.1.

41.1.2 Genital Organs of Sow

The reproductive tract of sow consists of ovaries, oviducts, uterus, vagina and external genitalia. The ovaries are oval in shape in maturity having a mulberry like appearance due to multiple follicles and or corpora lutea. These are enclosed in the purse of the peritoneum. The uterine body is short, but uterine horns are long and convoluted, measuring up to 1.5 m in pregnant animals. The cervix is poorly defined, being characterized by a thickened wall with the vagina is 7.5 to 11.5 cm long, smaller in diameter with a thick muscular coat. The vulval labilae is fairly

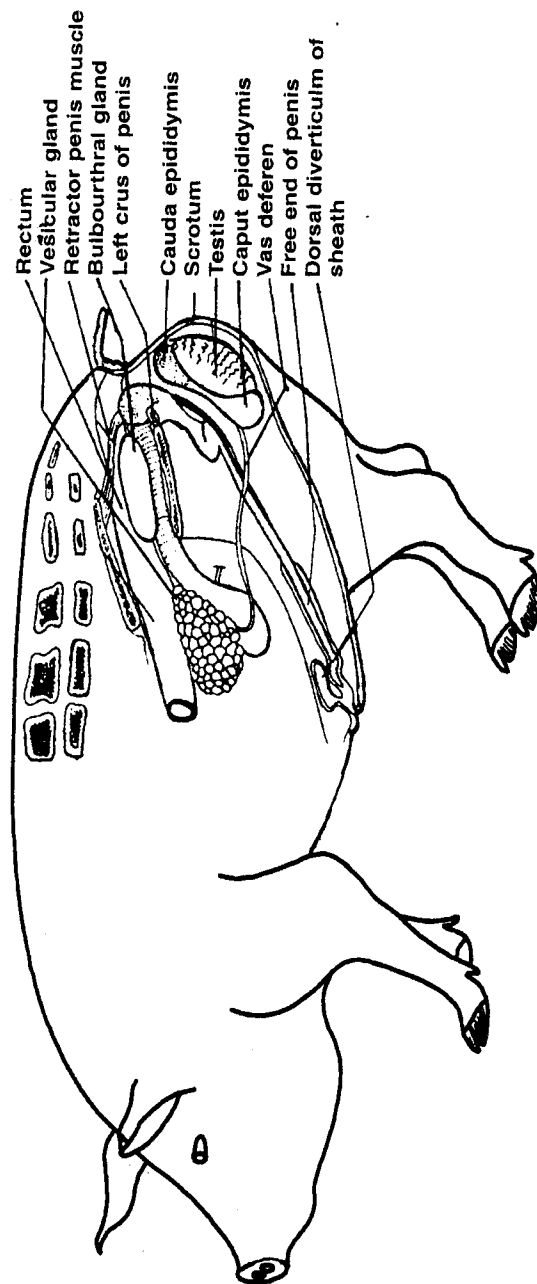


Fig.41.1.1.1 Genital Organs of a boar.

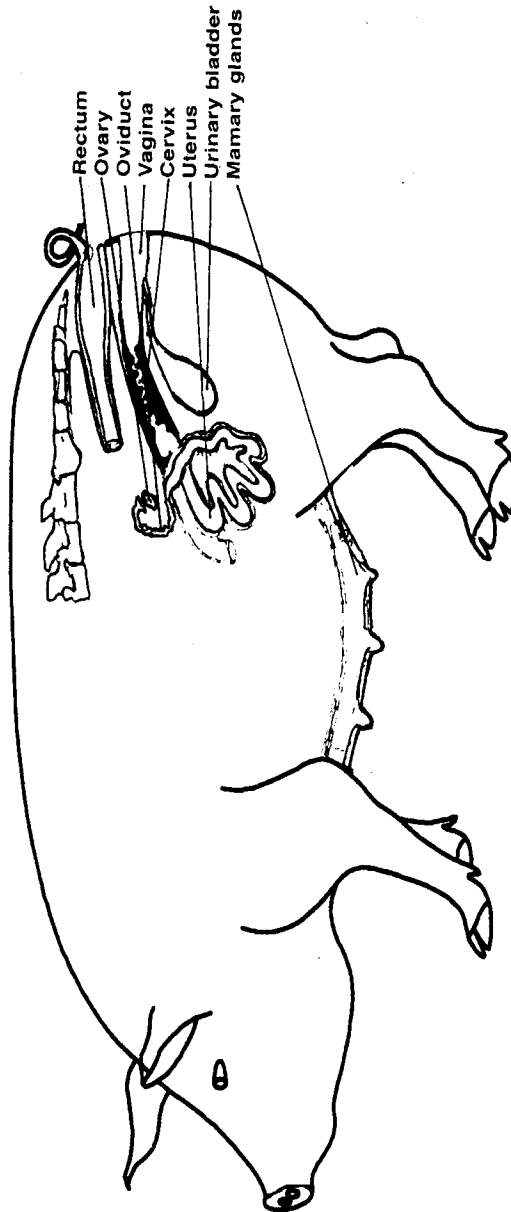


Fig. 41.1.2.1 Genital Organs of a sow.

thick and covered with a wrinkled integument. The vestibule is fairly long and vestibular glands are small in number. The genital organs of the sow are shown in Fig. 41.1.2.1.

41.2 Male and Female Puberty

Puberty may be defined as that phase which links immaturity and maturity, recognized in the gilt by the occurrence of the first oestrous period, i.e. when she ovulates for the first time. This first oestrous is almost invariably fertile and hence represents the beginning of reproductive capability in the gilt. Puberty in gilts occur at the age of 4-9 months. The variation in the age of puberty may be due to the breed differences, crossbreeding, feeding system, nutritional status, housing or stocking density and presence or absence of mature boar.

Puberty in male is achieved at the age of 6-11 months. The boar starts showing interest in gilt or sows during heat and mounts during true oestrous.

41.3 Heat and Methods of Detection of Heat

41.3.1 The Oestrous cycle

Oestrous is seen as sexual cyclic activity in the females which are not exposed to a male or artificially inseminated after puberty. Pigs are usually poly-oestrous and show cycles throughout the year. The expected length of the oestrous cycle is 21 days, with 18 to 24 days considered within the normal range.

Oestrous is characterized by a series of gradual behavioral and physiological signs. The important signs are as follows:

Symptoms of Heat

- ☐ Swelling and reddening of the vulva.
- ☐ The pricking of the ears in prick-eared breeds.
- ☐ Mounting of other females or allowing themselves to be mounted.
- ☐ Showing interest in the boar and the standing reflex, i.e. adoption of an immobile posture when pressure is applied to the back. At the start and towards the end of oestrous, the sow will show the standing reflex only in the presence of a boar. For a period at the height of oestrous, however, many

sows will show the standing reflex when pressure is applied on the back when the boar is absent.

- By a characteristic grunt or “roar” associated with heat.

41.3.2 Methods of Heat Detection

1. Observation of external genitalia

Increased sexual activity and excitement are observed and vulval swelling becomes conspicuous in sows during the oestrous.

2. Standing reflex to back pressure

The standing reflex is the most foolproof sign of heat. Those that are in oestrous will respond to pressure on the back, especially in the presence of a mature boar, by immobility, arching of the back, and pricking of the ears. This method is very useful in practice.

3. Use of the “boar smell” factors

The “boar smell” factors Which would make oestrous signs of sows clearly expressed are the pheromones produced in the submaxillary or preputial glands. The chemical androstenol had now been synthesized and is available commercially in aerosol form. A spray of this material is useful when no boar is available to increase detection rate in sows. This technique may be more effective if recording of boar’s wooing grunt is also played back in sow’s shed,

It must be kept in mind that perhaps about, 90% of heats can be detected fairly readily, the remaining 10% may be more difficult to detect. Thus, a dedicated and observant stockperson with adequate time available is required for achievement of highest detection rates.

41.4 Methods for Synchronizing and Inducing Oestrous

41.4.1 Synchronizing Oestrous

Synchronization of oestrous in gilts and sows would help in practicing batch farrowing to ensure maximum throughput in feeding and management. Synchronization of oestrous can be achieved by feeding of gonadotrophin Suppressing compound, methallibure, at a level of 100 mg daily for 20 days. At 21st day 750-1000 IU of Pregnant Mare’s Serum

Gonadotrophin (PMSG) is injected followed by 500 IU Human Chorio Gonadotrophin (hCG) at day 26. The animals will ovulate and insemination is done at day 26 irrespective of signs of oestrous. Progesterone is also administered for 14-18 days and animals are bred at oestrus, majority of animals would breed within 4-7 days period.

41.4.2 Induction of Oestrous

For prepubertal or postpartum anoestrous either PMSG alone or PMSG on day 1 with hCG is given 48-96 hours later or combination of PMSG and hCG is given on day 1, majority of animals exhibit estrus 3-5 days after treatment.

41.5 Mating

41.5.1 Timing of Mating or Insemination

Depending on the system of farming, sows are bred by natural mating or artificial insemination. Mating or insemination at very early or very late in heat results lower conception rate and litter size. The optimum timing of service at which both conception rate and litter size are maximized appears to be 10 to 20 hours before ovulation. This timing ensures that sperm and eggs arrive fresh at the same time at the site of fertilization. The importance of optimum timing of service during the heat period is illustrated in Figure 41.5.1.1.

41.5.2 Service behavior

If gilts or sows are approached for insemination earlier than optimum timing, the following behavior will occur:

- ☐ Walking around inseminator and smelling his legs when he comes into the pigsty.
- ☐ Hyperemia of vulva.
- ☐ Avoiding to be inseminated.
- ☐ Growling and mounting or riding more than one day after service.
- ☐ If the female is bred later than the optimum time, it could attract to the inseminator when he is in the pigsty. She will not allow service. Vulva feels cold. There are no more growling, mounting or riding in the females.
- ☐ If mating or insemination takes place in the optimum timing,

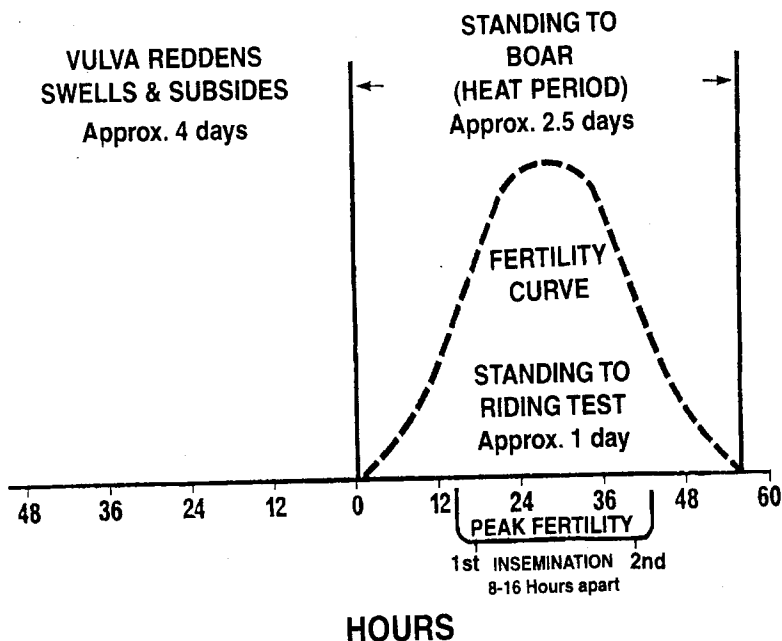


Fig. 41.5.1.1 Timing of Mating or Insemination.

the following behavior will be seen:

- ☐ Standing to back pressure, arching of the back and pricking of the ears.
- ☐ Drawing deep breathes when a few drops of semen are put in the tip of her nose.
- ☐ Immobility when touching vulva and mating or inseminating.
- ☐ Easily introducing of the spirally-tipped catheter along the vagina and into the cervical ridges.
- ☐ Abnormal vibrating when mating takes place.

41.5.3 Types of service

Single Service

The female is bred by one time using one boar's semen during oestrous. Its efficiency depends on the identification of optimum timing for service,

Double Service

During the oestrous, breeding is done two times during 8-10 hours. It not only increases the litter size but also reduces the

chances of failing to conceive to first service.

Multiple Service

Oestrous female is bred more than three times during the period. It is more time consuming and more demanding on boars. But for producers with a low litter size problem, it is the only way to boost the conception rate and litter size.

Double mating

In this method, the females are mated or inseminated by boar's semen of two breeds during 5-10 minutes, which may result into higher conception rate and larger litter size.

41.6 How to avoid embryonic losses?

The main steps which should be taken to minimize embryonic losses are the following:

- ☐ Take all possible steps to minimize risk of introducing disease.
- ☐ Ensure optimum timing and frequency of service.
- ☐ Avoid excessive food-intake after service, which is associated with losses of embryos.
- ☐ Avoid excessive environmental temperature in early pregnancy.
- ☐ Avoid imposing undue stress on sows in early pregnancy. The more peaceful and contented they are in early pregnancy, the lower the embryonic losses.
- ☐ Adopt a crossbreeding policy since crossbred sows suffer fewer embryonic losses than purebreds.
- ☐ Avoid very early weaning since it has been demonstrated that embryonic losses increases with early weaning. It is suggested that the earliest weaning time is between 18 and 24 days after farrowing.

41.7 Pregnancy Diagnosis

Reproductive efficiency of sows is very essential for maximum production in minimum time and this can be achieved by the proper diagnosis of pregnancy. The diagnosis of pregnancy in the sow has become an integral part of all modern swine production units in order to facilitate re-breeding or the culling nonpregnant sows. The pregnancy diagnosis program also monitors the overall management condition.

The pregnancy confirmation test looks for the presence of the products of conception and, with negative results, assumes that the sow is not pregnant. These procedures identify the products of conception either directly or indirectly and include: ultrasonic analysis; blood, urinary or fecal estrogen concentration; and rectal palpation. While pregnancy is confirmed at the time of the test, there is no guarantee that the sow will farrow. However, except for disease conditions, the incidence of pregnancy failure is extremely low and not worth the cost of time to find the occasional non-pregnant sow.

At present no confirmatory methods are employed in Government Pig Breeding farms except when the sow is not detected in estrus, it is assumed that she is pregnant. However, procedures that can be used in this respect include vaginal biopsy and blood progesterone concentration. These facilities are not available at Government Pig Breeding farms.

41.7.1 Laboratory Methods

Laboratory diagnosis of pregnancy lies on detecting changes occurring in internal tissues.

Vaginal Biopsy

The vaginal mucosa responds to the endocrine changes occurring during various stages of reproduction. A small amount of the vaginal mucosa is obtained with the help of biopsy instrument and is subjected to many histological procedures, such as fixation, staining and microscopic examination. The vaginal epithelium in pregnant pigs is two or three cells layers, while in non-pregnant pigs it is multilayered. This technique is time consuming and has limited practical applicability.

Immunologic Diagnosis

The immunologic techniques for diagnosis of pregnancy rely on detection and measuring of substances occurring in the conceptus, the uterus, ovary that enter in the maternal blood, milk.

Pregnancy-Associated Substances

Several protein like substances have been found in the maternal blood, where others may be secreted at higher levels

during gestation, thus can be used as indicators of pregnancy.

Pregnancy Associated Antigens

Antigens specific to pregnancy have been reported in maternal tissues, which are detected in maternal blood during the latter half of pregnancy and are of limited value in pregnancy tests.

Progesterone measurement

The blood or milk is collected after one oestrous cycle, and progesterone level is measured after 21 days.

The progesterone is low in non-pregnant animals than elevated in pregnant animals.

Estrone Sulphate Test

Estrone sulphate is a major estrogen produced by the conceptus and can be measured in maternal plasma, milk or urine in pigs. Estrone sulphate can be detected in maternal plasma as early as day 17 postmating, rising to a peak by day 26 to 29 and declining thereafter.

It is a better detector of non-pregnant sows than Doppler ultrasound.

41.7.2 Clinical Methods

Rectal Palpation

This method is only suitable for a few sows in small holdings, i.e. 1-20 sows. The hand is passed through the anal ring at least 30 cm and the cervix is found. The external iliac and middle uterine arteries are found and their size determined. During the oestrous cycle, the middle uterine artery is less than one half the size of the external iliac artery. After 30 days of pregnancy, both arteries are about the same size, i.e. 1 cm in diameter. During pregnancy, the middle uterine artery has a distinct fremitus (vibration during palpation). With practice, the accuracy of diagnosing pregnant and non-pregnant sows approaches 100%.

41.7.3 Detecting the Non-pregnant Sow

The detection of oestrous after mating is probably the easiest method of detecting non-pregnant sows. The most common testing procedure involves the use of a boar to detect

the sow in oestrous. Taking the sow to the boar's pen is a more effective means of detecting a sow in oestrous. In the presence of a boar, a sow in oestrous will assume a "standing reflex" posture and will allow intromission by the boar. The sows should be checked from 18 to 25 days after mating.

41.7.4 Ultrasonic Pregnancy Detector for Pigs.

Ultrasonic scanning is detection of a gravid uterus by means of a probe that transmits and receives a narrow ultrasonic beam. It is accurate from the fifth week of gestation. It is the most efficient method of confirming pregnancy in sows.

This procedure utilizes detection of the foetal heart rate and pulse (Doppler ultrasound), detection of foetal fluids in the uterus (A-mode or amplitude-depth ultrasound) or ultrasonic imaging (B-mode or echography). These three techniques are effective after 30, 25 and 20 days post-mating, respectively. For all three techniques, the Sow must be restrained to permit the proper alignment of the transducer in order to detect the sound (foetal pulse), the desired echo (foetal fluid) or the ultrasonic image (embryo). The accuracy of ultrasonic pregnancy diagnosis is limited by the ability of the operator to properly align the transducer towards the uterus. For the Doppler technique, the operator also must be able to identify the foetal pulse. For the A-mode transducer, a fluid-filled bladder could produce a false positive result. For the ultrasonic image, the operator must be able to identify the fluid around the embryo or fetus. An experienced operator can check an animal within 2 minutes. In order to minimize the number of open days, sows should be checked as early as conveniently possible after mating. Animals with negative results should be checked a second time within 1 week. These three techniques will detect all sows that are not pregnant at the time of testing. Thus, ultrasonic analysis is an excellent method of detecting those open sows that are not observed in estrus by the day they are checked, but sows with late embryonic, death may not be detected.

A large number of ultrasonic pregnancy detectors are available in foreign countries, which can be imported. The proper

detection of pregnancy will not only increase the efficiency of the farms, but also reduce the cost of production.

41.8 Feeding Strategies for Pregnant Females

In general, there are three practical feeding strategies for pregnant sows:

1. The first strategy is that high-low-high concentrates in diet are used respectively during periods from 'beginning of pregnancy to 40 days, from 40 to 80 days and 80 to farrowing. This is suitable to sows that have bad body conditions.
2. The second strategy means that concentrates in diet are gradually increased with days of pregnancy. This method can be useful to gilts that are in growth.
3. The third strategy is suitable to sows that have good body conditions, i.e. only in later period of pregnancy, these sows are given rations which consist of high energy.

The following points must be paid attention to:

- ☐ In early and middle period of pregnancy, sows and gilts must be given a number of green forages and roughages in their rations.
- ☐ Pregnant females must be supplied with enough protein and mineral content.
- ☐ Volumes of rations must be correspond to feed intake of the pregnant females.

42. ARTIFICIAL INSEMINATION (AI)

The reproductive system of the pig is amongst the most efficient of all mammals. It is the most effective of all the domestic animals- each result in 22 piglets born per sow each year. No doubt it is potentially a very fertile and fast growing species, but in India it has a poor reproductive performance and a slow growth rate. It is due to poor genetic endowment of exotic and cross-bred pigs and by inadequate management under the extensive conditions of a successful pig enterprise. The knowledge of normal anatomy and physiology of the female and male reproductive tract is fundamental to the achievement of a high reproductive rate of pigs through Artificial Insemination (AI).

The need for conservation of pig genetic resources at a worldwide level has been emphasized in the recent years due to the alarming disappearance of various domestic pig and local breeds. The embryos of pigs have been successfully frozen. The practice of pregnancy diagnosis in sows has a commercial future and accurate if performed with the necessary degree of professional skill, experience and modern tools. In view of the great improvement in recent years in the controlled breeding of pigs, there is the obvious possibility of pig improvement through reproduction and artificial insemination.

The efficiency of pig production in India did not made speedy progress due to increased reproductive problems. Currently sow produce an average of 1.8 litre per year with 7.2 pigs from each litter reaching market weight. There is a potential for improvement of productive performance by management of ovulation, fertilization and maintenance of pregnancy and effective diagnosis of pregnancy. If an average sow can produce two litters per year with 10 pigs marketed per litter, we can boost up our pig production. There is an urgent need to increase the reproductive efficiency of pigs, which can be significantly increased by the use of artificial insemination in pigs.

42.1 Pig Improvement through Reproduction

It is well recognized that the reproductive performance of

females is often a major factor limiting pig production systems. There is a significant difference between the reproductive potential of sows and the reproductive achievement at farm level. Allowing 114 days for pregnancy, 21 days for lactation and 3 days for weaning to re-mating interval, the sow has the potential to produce 2.6 litters per year, but achievement of this target is extremely rare. In developed countries, 20 pigs per sow/ year is possible and is being achieved, while in India, the Government Pig Breeding Farms are hardly producing 10 pigs per sow/ year.

42.2 Pig Reproduction Cycle

To achieve the full reproductive potential, she must complete the reproductive cycle in the shortest possible time while producing the maximum number of piglets.

Oestrous Cycle

The sexually mature female sow has regular oestrous cycles throughout the year. The length of the cycle is 21 days (normal range 18-23 days) and the period of sexual receptivity lasts about 50 hours (range 24-72 hours). The oestrous cycle holds the key to reproduction because it synchronizes mating and ovulation and ensures that the uterus is ready to receive the fertilized ova.

Improved fertility of sows and boars is now possible through estrus synchronization with the prostaglandin. The semen preservation, Pregnancy Diagnosis, Superovulation, multiple birth and non-surgical embryo transfer and implantation can increase the number of piglets from genetically superior sows and boars. Embryo transfer technology plays an important role in revolutionizing genetic improvement in breed conservation and improved productivity in pigs.

Reproductive efficiency in pigs will remain valuable not only for producing offsprings but for economic production of pigs and their products.

Optimal dietary energy and nutrient levels during various phases of reproduction will help in achieving goals.

As one creates a vision for the future, nutrition and feeding will play an increasing and changing role in pig production. One of the serious problems in pig production is low

reproductive efficiency. Improved housing providing environmental control for pigs, animal welfare and comfort for increasing the reproductive performances and disease control for improved feed utilization.

42.3 Country Background

As per the Indian Livestock Census (1992) the total pig population of India is at 12.95 million, which comprise of 1.85 million Exotic and cross-bred pigs and 10.93 million indigenous pigs. The annual growth rate is estimated at 10.80% for cross-bred and 4.21% for indigenous pigs. The production potential of indigenous pig is very low. Piggery is one of the dominant branch of Indian Animal Husbandry and employing socially poor and weaker section of the society. The production potential of desi pig is very low, hence it can only be increased by cross breeding. But the exotic and cross bred pigs of India are not sufficient to meet the present demand, However, its use can be increased to 10 times by the use of AI in pigs.

In India, the Pig Breeding farms at Government Sector, Agricultural University, Veterinary Colleges, Krishi Vigyan Kendra and All India Co-ordinated Research Project on Pigs (AICRP on Pigs) are numbered at 158, which comprise of 70 pig breeding farms in North-Eastern Region and 88 farms in rest of India.

North-Eastern Region

The North-Eastern region, a vital entity of great Indian land has been in the limelight in spite of being geographically in the extreme corner of the country. By virtue of being pork as a major source of animal protein, the region acquired special importance in India. Pig Breeding Farms in North-Eastern Region represents 44.31% of total Pig Breeding Farms in India. The Pig Breeding Farms in North-Eastern Region are highest i.e. 11 in Meghalaya, followed by 10 in Arunachal Pradesh, 10 in Mizoram, 9 in Nagaland, 8 in Manipur, 8 in Tripura, 7 in Assam and 7 in Sikkim.

In spite of large number of farms, the exotic boar numbers at Pig Breeding Farms are not sufficient to cater the need of

farm and farmers and private pig breeding farms and co-operative societies.

The annual growth rate of exotic and cross-bred pigs is estimated (Indian Livestock Census 1987 and 1992) at 30.17% in Assam, 24.57% in Tripura, 13.07% in Nagaland, 12.23% in Mizoram and 8.45% in Sikkim in spite of highest pork consumption in these states.

42.4 Major Constraints to improved Piggery in India

The major problem facing small-holder pig farmers in India is that they have poor access to the resources needed for transition from the traditional management practices to a modern system of production. The problems they face are largely due to the socio- economic and technical infrastructure.

Technical Constraints

Inadequate Feed and Nutrition

Malnutrition and nutrition are major problems for the country due to unavailability of balanced and nutritious feed for pigs.

Poor Genetic Make-up

The poor genetic make-up of Exotic and cross-bred pigs maintained at Pig Breeding Farms has evolved largely as a result of inbreeding, non-import of new exotic strain, influenced by environmental factors and level of technology.

Selection has been for survival under high disease challenge and inadequate feed and water supply rather than for high levels of production.

Animal Health and Diseases

Pig Diseases like Swine Fever, Foot and Mouth Disease, Swine influenza, Swine pox are the major constraints to low productivity of the pig industry. The diseases with nutritional disorders are very common in the country.

Low Standard Management System

At farmer's level, the standard of pig husbandry is generally low. Diseases are not timely and adequately prevented or treated. Pig Breeding is not controlled, records are not kept, and animals are not identified.

Reproductive Efficiency

Reproductive inefficiency refers to delayed puberty and extended postpartum an oestrous periods in gilts and sows resulting in increased age at first farrowing and long farrowing intervals. It also refers to decreased litter size and number of litters/year and number of piglets born/ year.

Socio-economic and Infra-structural Constraints

The socio-economic constraints include the level of monitory investment, the provision of technical service to support the development of piggery, the availability of marketing and related infrastructures and pricing policies.

Future Strategies for Piggery Development in India

Strategies developed so far are geared to the alleviation of the major constraints discussed above. Because of the biological nature of Piggery and varying agro-climatic conditions, these strategies will need to be reviewed and modified from time to time.

Government of India, Ministry of Agriculture, Department of Animal Husbandry & Dairying had launched a Centrally Sponsored Scheme "Assistance to States-for Integrated Piggery Development" in which 100% grant-in-aid is given for establishment/ strengthening of pig breeding farm in the states for boosting up piggery development, with an objective to make available exotic and cross-bred piglet at a very competitive price to farmers, and ultimately to improve productivity. This scheme has a programme of training component for training farmers in piggery.

42.5 What is Artificial Insemination (AI)?

Artificial insemination (AI) is the deposition of spermatozoa in the female genital tract by artificial instruments rather than natural service. It enables the use of superior boar to 10 times more number of sows. The cost of artificial insemination is lower than that of natural service.

The practice of artificial insemination on a commercial basis exists in most of the countries of the world - the Netherlands, Russia, Federal Republic of Germany, Denmark.

United Kingdom, Japan, United States and China. It can offer better possibilities of health control, reduction in the cost of breeding and management to extend the usefulness of superior boars to large number of sows. In countries with high density pig populations, artificial insemination cost is lower than that of natural service.

In our country this practice has been very slow to gain acceptance for several reasons such as, lower fertility and small litter size compared to that obtained in natural service and high cost involved in the expansion of artificial insemination practice. The advancement in the technique would offer possibilities of its use to satisfy the future needs of Indian pig industry. It will enable the maximum use of genetically superior boar for more sows. It will also provide a wider variety of new genes for herds at nucleus level for greater intensity of selection and to produce replacement breeding stock in commercial herds. The high cost of importing live pigs and problems of health certification have stimulated the increasing importance of artificial insemination.

42.5.1 Advantages of AI

- ☐ Very large number of offsprings can be produced from elite boar with the help of AI.
- ☐ Some sexually transmitted diseases can be prevented by use of AI.
- ☐ Boar produce large volumes of gel from the bulbo-urethral (Cowper's) glands in addition to large volumes of gel free semen 150-300 ml. After collection and evaluation of the semen for sperm density and motility, ejaculates can be extended 2 to 4 times. A 50 ml volume of diluted semen with 5000 million spermatozoa is necessary to inseminate a sow. At least two inseminations during oestrous are recommended for sows. A boar ejaculate can be successfully used to inseminate 10 females.
- ☐ The conception rate and litter size in pigs artificially inseminated at 36 hr. after oestrous gives highest litter size and insemination just after ovulation gives maximum conception rate(%). For getting the maximum effect of both

- litter size and conception rate two inseminations are necessary.
- ☐ There is no longer necessary to maintain costly boar on all the breeding farm and on private farms.
 - ☐ Possible to reduce the number of boars needed for pig Breeding farm.
 - ☐ Reduction in cost of breeding and management.
 - ☐ Maximum use of superior boar to large number of sows.
 - ☐ No need to maintain boars at farmers level.
 - ☐ Takes less time and energy.
 - ☐ Systematic Monitoring of Semen
 - ☐ Enables breeders to benefit from the advances in genetic selection.
 - ☐ Uniform Pork Production with better carcasses.
 - ☐ Increased number of piglets.
 - ☐ Reduction in diseases.

42.5.2 Commercial AI in Pigs of the World

The practice of AI on a commercial basis exists in the Netherlands, Russia, Federal Republic of Germany, France, Australia, Denmark, United Kingdom, Japan, United States and China. The use of AI in pigs is increasing significantly and is estimated to involve between 20 to 25 million sows and gilts annually. AI is now used for over 35% of pig services in USSR, Netherlands, Norway, Finland, East Germany, UK, France and China.

42.6 AI in India

42.6.1 Status of AI in India

So far it has not been tried in India, as recommended by National Commission on Agriculture (1976), and there is an urgent need to introduce this technique in India. The introduction of this technique would offer possibility of its use to satisfy the future needs of Indian pig industry. It would also enable the maximum use of genetically superior boar for 10 times more sows. It would also provide a wider variety of new genes for herds at nucleus level for greater intensity of selection and to produce replacement breeding stock in Government Pig Breeding Farms. The high cost of import of pigs has stimulated

the increasing scope of AI in India.

42.6.2 National Commission on Agriculture (1976)

The comments of National Commission on Agriculture (1976) on Artificial Insemination in Pigs were as follows:-

“32.1.23 Artificial Insemination (AI) has been used for effecting pig development in some countries that produce high quality pigs. In our opinion, it would be advisable to give trials to this method of breeding in order to determine how it would pan out under Indian conditions. If found practicable, it should be adopted in important pig breeding stations. As the equipment for AI in pigs is not manufactured at present in India, local manufacturers of AI kits should be encouraged to fabricate the kit by providing them with necessary samples and design.”

Recommendations of NCA (1976)

The Recommendations of NCA on AI in pigs are as follows:

“15. Artificial insemination (AI) should be tried in the pig to find out how this method of breeding will pan out under Indian conditions. If found satisfactory, it should be adopted in the important pig breeding stations. (Paragraph 32.1.23)

16. Attempts should be made to get Indian manufactures of AI kits interested in fabrication of AI kits for swine.” (Paragraph 32.1.23)

42.7 Technique of AI

42.7.1 Management of Boars for AI

Boars are the most important part of the AI programme, and they need to be managed in consultation with the gynecologist.

Poor semen collection is just the same as no AI programme, whether that is on farm or from a commercial stud.

To optimize production, boars should be kept at an environment of 60°F. The boars can cope with cooler temperatures. But temperatures warmer than 83°F can begin to affect the boar's semen quality and by 96°F most boars would be affected. Maintaining suitable temperatures can be difficult in some countries. Drippers, evaporative coolers, fans and in some circumstances air conditioning can be helpful.

From a health point of view all boars should be isolated, examined and vaccinated before entering the herd. Common

vaccinations include those for parvovirus, erysipelas and leptospirosis.

A parasite control programme is also important. It should be remembered that certain drugs can affect semen quality.

Boars should be fed according to their body condition. Unlike natural service boars where producers may keep their animals on a limited plane of nutrition to reduce their growth rate, AI sires should not be so aggressively limited.

On average boars will be fed about 5 lb of feed per day of a gestation diet. It is suggested that the feed is top dressed (if enough boars can justify the costs it may be pre-mixed), with a specific boar nutrient supplement containing added vitamins C and E and zinc, as there have been links with these and increased semen production.

Collection management varies depending on individual boars. Generally boars that are under 7.5 months should not be collected on a regular basis. Between 7.5 and 11 months the boar should be classed as adolescent. This means that he should not be collected more than once per week.

42.7.2 Collection and Handling of Semen

Boar semen is easily collected in an artificial vagina. The most satisfactory method for collecting semen is by fixation of the penis by the hand method using a dummy sow as a teaser. A dummy sow, made of galvanized iron is fixed to light wooden platform so that the boar keeps it in place by means of his own weight. When the boar mounts the dummy the operator guides the penis into artificial vagina and tries to catch and hold the penis through the vagina with his right hand. The artificial vagina is fixed at proper temperature, 105 to 110°F, and pressure. As soon as penis is fixed in hand, the boar will begin to ejaculate and semen is collected in plastic bottle. Boar semen is ejaculated in fractions and from 10 to 15 minutes may be required for complete ejaculation. It is common practice to fractionate the ejaculate by allowing the accessory fluid and get to escape and collecting only the sperm rich fraction. This can be performed by filtering through a coarse gauge filter. The volume of ejaculate



Fig.42.7.2.1 Collection of Semen at Aizwal, Mizoram



Fig. 47.7.2.2 Collection of Semen at Seilesh, Mizoram

varies from 100-350 ml. The semen collection can be done once or twice a week without affecting the amount of spermatozoa.

The first three collections should be analyzed, but not used.

Once a 'picture' of the boar's semen quality has been established, the boar should be introduced into the AI breeding programme. When the boar is older than 11 months, he can be collected every five days.

Boars reach peak semen production at approximately 24 months of age, but with an AI programme these boars should be removed from the system to maintain genetic progress.

The stockperson usually supervises the moving of the boar from his pen to the collection area.

Once the boar is in the pen, the collector will empty the prepuce sac, expelling rotting urine which is a high bacterial source. It is therefore advisable that two gloves are worn. One is the vinyl glove that should be close fitting, the other is an over glove that is larger and easily removed once the boar is ready to ejaculate.

The semen is collected from the boar using the gloved hand technique. It is absolutely necessary that clean, disposable vinyl gloves (not latex) are worn as the bare clean hand carries many contaminants such as staphylococcus. All hands should be odour free and washed using an anti-bacterial soap. Particular attention should be paid to the nail bed areas.

When handling either raw or diluted semen it should be remembered that the product is a fragile commodity made of billions of cells that can be very easily damaged. The semen must be collected into a clean, insulated container.

The container has a filter placed over the top to keep any large contaminants, such as dirt or gel, out and should be held as close to the boar's penis end so as to avoid as much temperature cooling as possible.

The boar should always be held in a manner that allows the semen to fall directly into the container.

42.7.3 Handling of Semen

Once the collection is complete, speed is important as

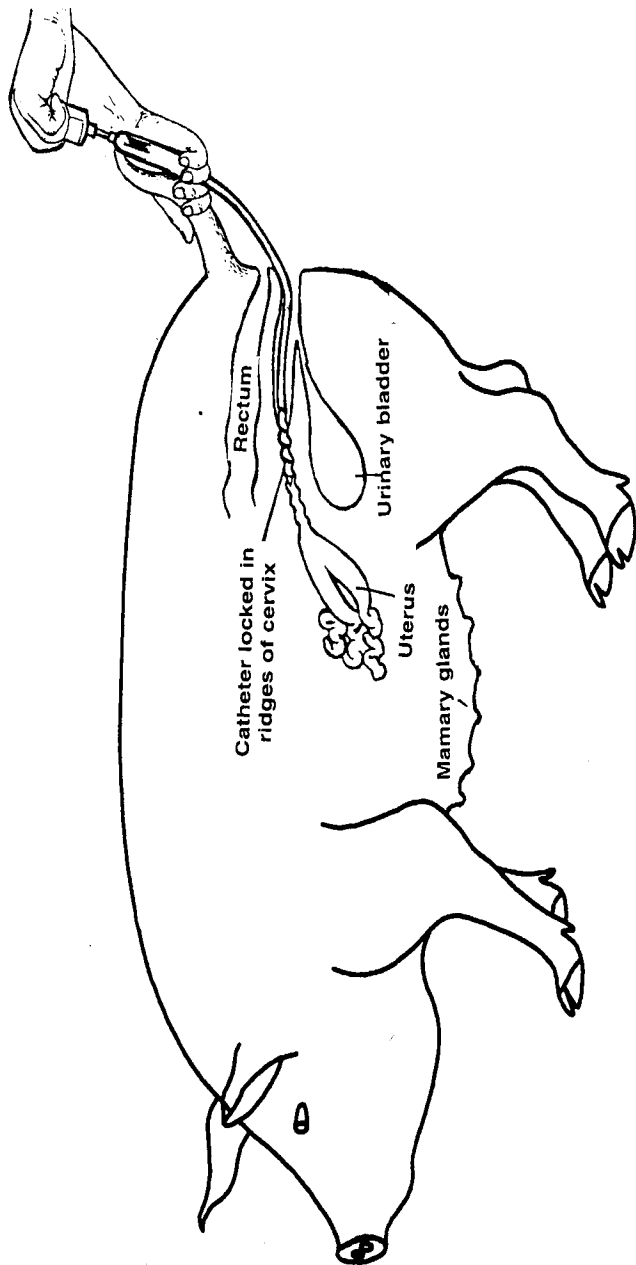


Fig. 42.10.1 Insemination Technique in pigs.

semen dilution needs to occur as quickly as possible. If semen has to be held for even a short period of time until processed and diluents added then it must be kept in a warmed cabinet (between 32-38°C).

Holding raw semen should be avoided as death to a large number of cells can occur.

When handling semen, all the components that are used in the system should be as clean as possible. Dust contamination should be kept to a minimum and the laboratory should be clean before semen is brought in.

The use of UV lights in a laboratory can help reduce bacteria levels and further improve the cleanliness of the laboratory.

These lights need to be used at night when people and semen, which can be harmed, are not there.

42.7.4 Semen Evaluation

The semen should be analyzed for motility, density and colour and its temperature taken. If thermometers are used to monitor the raw semen they should be warmed to an average temperature of 33°C, so that when it is added to the raw semen a shock does not occur.

The volume of the boar ejaculate varies from 100-500 ml depending upon the age and method of collection. The sperm density can range from 100 to 1500 x 10⁻⁶ sperms per ml. The total sperms concentration per ejaculate may be 50,000 to 80,000.

The evaluation for quality is done by direct microscopic examination at 30-35° C on a warm stage. The sperm motility is assessed soon after its collection. Good samples will show a wave motion. The motion is more pronounced in the sperm rich fraction. In a poor samples there is a marked, clumping of the spermatozoa. The density is assessed by haemocytometer count. Evaluation is also based on semen volume, appearance, motility rating, sperm number morphology count for abnormal form and proportion of live and dead spermatozoa.

42.7.5 Dilution of Semen

Diluted boar semen retains motility up to 4-8 days. The threshold number of spermatozoa required for normal fertility ranges from 2000-3000 million in a volume of 50 ml.

Boar semen is diluted 1:1 in Illinois variable Temperature (IVT) diluent, and poured in 20-50 ampoules and sealed. Before use, dilute further with IVT up to 200 ml. The modified diluent has no egg yolk and is saturated with carbon dioxide. An average ejaculate can be diluted to perform 25-30 inseminations depending upon the time of diluent and method used.

The ready to use diluents are also available in market.

In good diluent semen can be stored up to 3 days at 16-18° C without loss of motility. But EDTA diluent gives a 5% higher conception rate than IVT.

The semen extender (or diluent) should be fully dissolved and added to the raw semen provided the temperature difference is no more than 1.5°C.

Once the semen is extended at a minimum rate of four parts extender to one part semen, temperature fluctuations are less of a concern; however, the ambient temperature of the room should still be above 14°C.

42.7.6 Packaging, Storage and Transportation

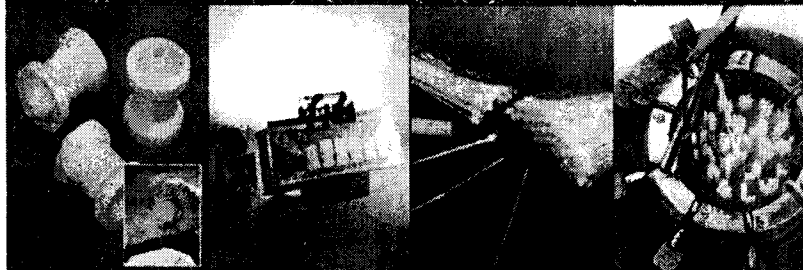
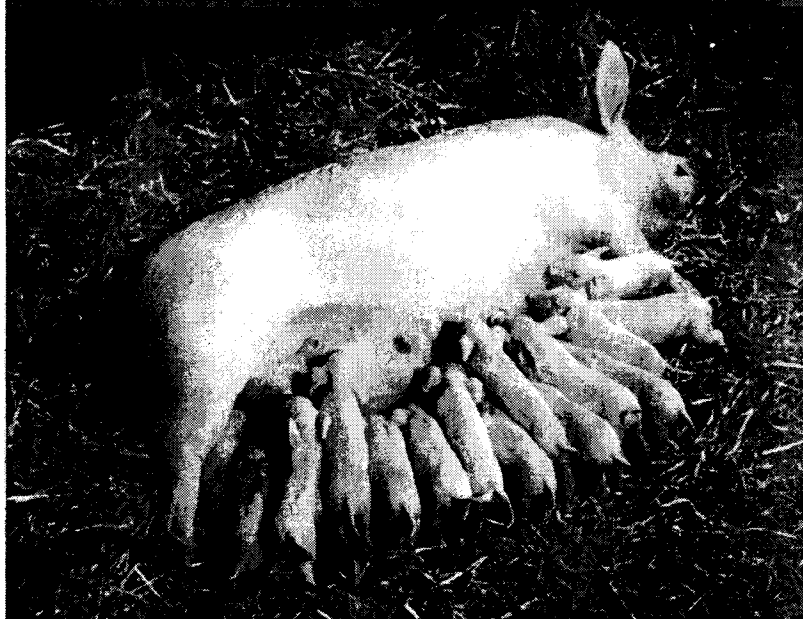
Once the semen is packaged it will be distributed out to the farms. It should always be labeled with the boar identification and either a date of collection or a date to be used by.

All semen should be stored at a constant temperature of 64°F until ready to use.

42.8 Deep Freeze Storage

Deep Freezing of boar semen would greatly facilitate international exchange of semen and long term storage of semen from valuable boars. Various techniques of deep freezing have been used by various scientists but they are not applicable in routine commercial practice because of low fertility as compared with fresh semen. Farrowing rates with frozen semen will probably never be as high as those from liquid semen. However, an improved technique would make frozen semen more useful

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in the production of great grand parent stock and parent replacement stock. The conception rates and litter size with frozen thawed semen can be improved in future by development of techniques of freezing and thawing.

42.9 Time of Insemination

Time of insemination is the principal factor governing fertility and litter size. The ovulation occurs between 36-50 hour after the onset of heat but the best results can be obtained by performing insemination near the middle of heat. Sows should be inseminated 12 to 24 hours after the onset of standing for the boar or owner testing.

42.10 Insemination Technique

The equipment for insemination consist of a catheter, which is a long rubber, tube similar to the boar's penis, a thin walled plastic bottle which holds the semen and is attached to the catheter. The catheter is first lubricated with liquid paraffin and then inserted carefully and firmly upward into the vagina. Then the catheter is twisted gently, anticlock wise, until it locks in the cervix. After fixing in correct position, the plastic bottle is attached and squeezed very gently to allow the semen to flow. The insemination will complete in about 10-15 minutes. The insemination technique and correct method of insertion of catheter is shown in Fig. 42.10.1 and 42.10.2.

42.11 IMV- A Pioneer Company in AI

IMV, France is a Pioneer company in AI in pigs which introduced the disposable insemination equipment with least cost and ready availability of semen storage technique and evaluation method for the benefit of pig farmers.

42.12 Artificial Insemination Services (AI)

As recommended by National Commission on Agriculture (1976), there is an urgent need to prepare and implementation of policy issues, guidance, work programmes and projects related to AI for introduction of AI in pigs of India.

- * Acquisition of high level pedigree boars for semen collection through import.
- * Processing of high quality semen storage and distribution

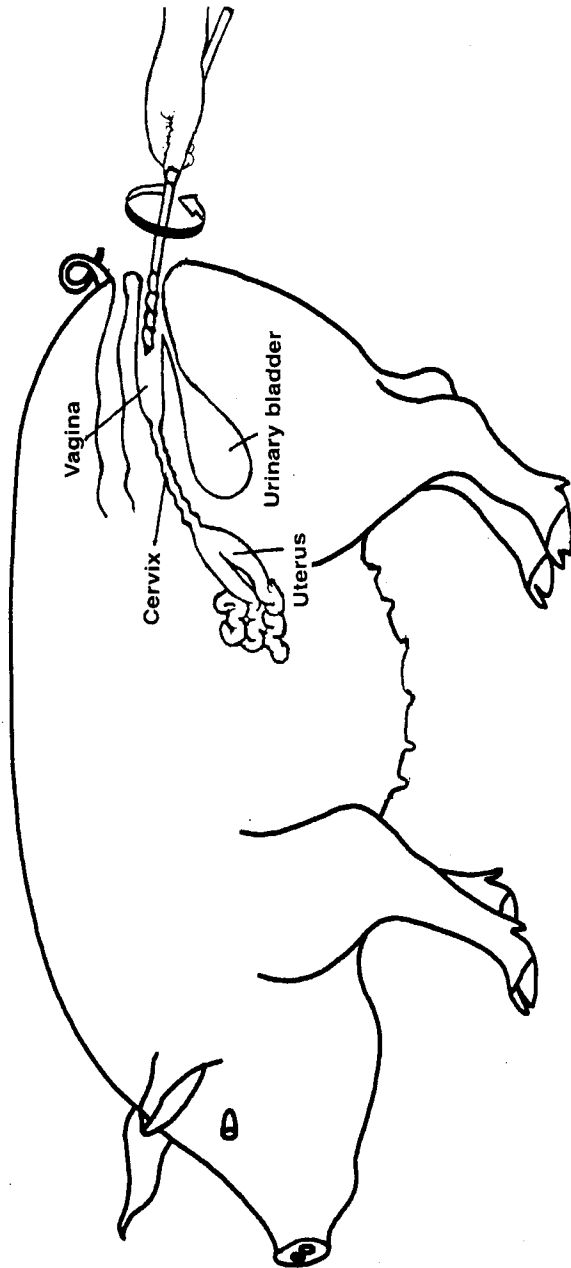


Fig.42.10.2 Correct technique of inserting catheter.



Fig. 42.10.3 AI at Pig Breeding Farm, Seilesh, Mizoram, India



Fig.42.10.4 Training of AI Technique by IMV Expert

system.

- * Applying of AI at field level.
- * Procurement, storage and distribution of AI equipments.
- * Training of Veterinary Officers and technicians.
- * Preparation and distribution of extension aid materials for AI.

In order to implement the above strategies, most attention may be given to North-Eastern area.

Justification of introduction of AI Service

The Pig productivity in India a very low mainly due to inbreeding and level of technology. There is a great need to improve pig performance, in order to satisfy both domestic and export requirements for pork and pork products.

43. EMBRYO TRANSFER IN PIGS

Application of the technique of Artificial Insemination in animals has provided a considerable opportunity for genetic improvement of the livestock. In particular, the availability of methods for low temperature preservation of semen has facilitated the extensive use of chosen sires. In contrast to this, the ability to store embryos and its transfer to recipients, has increased the possibility of multiplication of genetically superior sows.

43.1 Advantages of Embryo Transfer

1. In recent years, the application of the technique of embryo transfer in pigs has provided a considerable opportunity for effective exploitation of the genetic potential of the genetically superior sows.
2. It is an excellent method of rapid multiplication of rare or commercially desirable breeds.
3. It would be helpful in advancing the overall number of superior animals produced in short period.
4. The potential of identical multiples are enormous. The number of progeny can be increased by dividing the embryo in-vitro. Although this process requires micromanipulation skill, it can be done in few minutes.
5. Embryo transfer in pigs would offer an extremely convenient and much cheaper method for import and export of pig breeds as compared to the transportation of animals.
6. Export of frozen embryos after quarantine is cheaper than shipping adult animals, and has the advantage that piglets are born to "native" mothers will acquire passive immunity to local diseases from the sow's colostrum.
7. Within the last 60 years economic pressure have caused considerable changes in the choice of breeds of pigs. Effective selection depends upon the availability of great genetic variation and it is important that breeds should not be allowed to disappear merely because they are of no current economic importance. The effective method of pig embryo freezing in future would offer a convenient method for preservation of

rare breed as an embryo. A bank of frozen pig embryos would be possible for preservation of rare breeds at international level.

43.2 What is Embryo Transfer?

Embryo transfer is the removal and transfer of a developing embryo from the reproductive tract of one female to that of another, where the pregnancy may continue. The ovum and egg are the general terms used to refer to the female gamete and early embryo. The ovulated ovum is technically termed an oocyte which, grow up on fertilization, becomes an embryo, and when the major organs form, a fetus. Embryo transfer refers to placing an embryo into the lumen of the oviduct or uterus. In a broad sense, however, it is often used to describe collectively a variety of techniques such as superovulation of the donor, synchronization of oestrous in the donor and recipient, and various manipulations of the embryo in vitro, in addition to the physical embryo transfer.

It offers a unique opportunity to increase the selection intensity on boar dams and thus enhances the possibilities of producing highly selected genetically superior boars for progeny testing and field artificial insemination programs.

The embryo transfer technique may be the means of getting piglets from old sows no longer able to bear them, aged sows would often have ovaries which produce normal eggs but they are incapable of maintaining a normal pregnancy. The application of this technique for the rapid multiplication of small population of imported animals, increases the effect of improvement. On the international front, embryos are obviously much cheaper to transport than live pigs. The risk of introducing contagious diseases would be lower and simpler to deal with. When pig embryos are transferred to indigenous recipients, the transplant piglet would get appropriate passive immunity from the dam's colostrum and thus developing immune system would be able to deal with pathogens in the new environment. There may be other physiological and behavioral adaptations, that are facilitated when the piglets are born in a particular environment

rather than being placed there at an older age.

The use of embryo transfer to help in the preservation of rare breeds is another important aspect. A bank of frozen embryos from pig breeds can be easily maintained, and the embryos which could be thawed out and transferred at a later date as required.

The embryo transfer enables production of large number of superior boars from selected sire and dam lines, to build up a seed stock or germplasm pool, thus embryo transfer technology would be useful in increasing the selection pressure in progeny testing performance.

43.3 History and Development

Historically, the development of the embryo transfer technology was started long back. However, the history of the commercial embryo transfer technology is short. The first successful embryo transfer was performed with rabbits by Walter Heape (1891). However, offspring produced by embryo transfer in pig was in first time in 1951 by Kvasnickii.

Successful micromanipulation of early stage swine embryo resulting in the birth of multiple offspring from single embryo. Important research work in the field of microsurgery to produce identical piglets has been carried out in the past, resulting in more piglets than conventional embryo transfer technology. "

Development in India

The interest in embryo transfer in pigs in India is on experimental stage and increasing due to the implantations of vital organs of the pigs in humans.

43.4 Applications of Embryo Transfer in Pigs

Embryo transplantation may play a positive role in a National Breeding programme by shortening the generation interval. The deep freezing of the embryo in future and establishment of National Embryo Bank would play an important role in the conservation of valuable indigenous breeds in its original form. It is possible to use embryo transfer within herds to obtain more replacements from the best animals. The embryo transfer technology can be used in several ways to enhance the

pig development and improvement schemes.

1. Enhanced Reproductive Rate

Embryo transplantation allows a selected sow to produce more number of viable piglets in a year. The embryo transfer offers tremendous potential for genetic improvement through enhanced reproduction of genetically superior females.

2. Offspring from Infertile Females

Failure of female to produce offspring may occur in spite of production of fertile ova, normal fertilization and early implantation development. Various conditions of the female reproductive tract, particularly in older sows, preclude normal maintenance of pregnancy. Offspring can often be produced from these females by flushing the embryo from the reproductive tract during the first week of development and transferring it to the uterus of a fertile recipient.

3. Import and Export of Pigs

Deep freezing of pig embryos would open up the possibilities for the trade both locally and internationally with embryos. In this way breeds with desirable genetic traits could be introduced into new areas as embryos. Advantage of being born into the local environment of their future life. Transport cost would be minimized as compared to the costs of exporting the live animals.

4. Eliminating the Risk of Transmitting Disease

The risk of transmitting a disease, which is an important consideration when animals are moved between countries, is probably reduced by importing embryos. Many pathogens are unable to penetrate the zona pellucida, and disease transmission is less likely to occur by embryo importation than if an animal is imported after birth.

5. Induction of Multiple Births in Sows

Micromanipulation experiments on pig embryos have shown that the embryos, in spite of a great reduction in their cell number, are able to develop through early cleavage and up to blastocyst formation. The simple bisection of fully compacted late morulae or early blastocyst allows the production of identical

piglets in sows.

6. Production of Breeding Boars

Embryo transfer in future would be used to produce a high proportion of young boars for progeny testing.

7. Production of Breeding Sows

The very high proportion of sows currently needed to breed replacement females. The considerable scope exists for increasing genetic response by applying embryo transfer on this pathway. The selection intensity in the sow to sow pathway is increased with the use of embryo transfer technology and less number of sows are needed to breed replacements respectively.

8. Production of Disease Free Progeny

The embryo transfer technology is useful in control of disease and in saving genotypes from infected animals. The embryo transfer would be a valuable tool in the production of clean herds from animals infected with pathogens.

Infectious viral diseases are transmitted to embryos due to the transfer on the surface of the gametes so that infection occur at fertilization or the developing embryo is infected with virus in the reproductive tract of the sow. A few viruses including some RNA viruses have been implicated in infection of gametes. The swine pathogens for which there is good evidence that they are not transmitted by embryos with intact zona pellucida and that have been washed prior to transfer. The *Brucella* is not transmitted by embryos with intact zona pellucida. It may also prove beneficial in getting brucellosis-negative offspring from elite brucellosis- positive sows.

43.5 Embryo Transfer Procedure

There are several steps which are involved in the embryo transfer procedure in pigs.

43.5.1 Selection of Donors

The donor is the genetic mother from which embryos are recovered. Every regulating sow or gilt can successfully respond to superovulating treatment and be used for embryo transfer. However, the experiments have shown that the response of gilts and very old sows is generally low. The ideal sow is 2 to 3 years

old with a normal sized reproductive tract, no signs of endometritis and vaginitis, regular cycling, well-nourished and with a regular parturition record.

The selection should be based on three criteria: genetic superiority, reproductive ability and market value. In exceptional cases, genetically outstanding sows which have had several piglets and then do not conceive again can be used, for the production of additional piglets.

43.5.2 Superovulation

One of the key steps in embryo transfer is superovulation. It is possible to recover a satisfactory number of embryos for transfer after superovulation. The superovulation is defined as the treatment of a sow with hormones so that more than one ova are ovulated. The superovulation treatment starts between days 15 and 16 of the cycle, the day of oestrous being day 0. Although thousands of follicles are present in each ovary of sow, only 12 to 16 follicles usually ovulates per reproductive cycle. With the help of superovulation it is possible to get 24 to 50 normal embryos per cycle. In order to increase the potential yield of embryos it is first necessary to induce the donor animal to have several ovulations.

43.5.2.1 Superovulation with Gonadotrophin

Treatment of sows with Gonadotrophin leads to ovulation of numerous ova. Gonadotrophin treatment is usually initiated between days 14 and 16 of the estrous cycle, causing ovarian follicles to grow. Two or three days after the start of treatment prostaglandin or an analog is injected to terminate the luteal phase of the estrous cycle prematurely by lysing the corpus luteum, about two days later the estrous occurs. Estrous lasts for about half a day, ovulation occurs about one-half day after the end of estrous.

There are number of factors which influences the superovulation in the sows, these are dose of the drug, breed of sow, individual variation, individual estrous cycle, day of cycle when treated, nutrition and season. The variation in the follicle population may lead to the variation in response.

43.5.2.2 Cyclic Animals

The most commonly employed gonadotrophin is pregnant mare serum gonadotrophin (PMSG), which is a glycoprotein with a very long half-life in pigs so that one injection is effective in stimulating follicle growth over a period of several days. An injection of 1000 I.U. PMSG is commonly given on day 16 of a normal estrous cycle followed by 500 IU of hCG after 3 days, donors are checked daily for oestrous and bred at least twice by the boar or AI on day 0 and every 24 h while in heat. Embryos are collected some 4-6 days after hCG injection.

43.5.2.3 Prepubertal gilts

For research purpose and for developing embryo transfer technology in pigs, prepubertal gilts are an inexpensive source of embryos because the superovulation treatment is not complicated by the presence of an oestrous cycle. The gonadotropic treatment can be applied any time. Doses of 250-1000 IU PMSG in combination with 500 IU of hCG is injected 48 h later. Insemination is done 24 h later, and embryos are collected some 4-6 days after hCG injection.

43.5.2.4 Superovulation with Altrenogest treatment

Kang and Wu (1991) administered altrenogest 20 mg daily for 18 days to postpubertal gilts, with PMSG given on day 19 and hCG after a further 72 h. In pigs used to supply oocytes for research, Pursel and Wall (1995) regulated oestrous by altrenogest. Donors were injected with 1500-2000 IU PMSG at 24 h and 500 IU hCG at 103 h after the last feeding of altrenogest.

43.5.3 Breeding the Donor pig

For optimal fertilization rates, the donor pigs should be mated or inseminated every 12 h throughout oestrous. The volume of inseminate should be 50-100 ml, which should contain 4000-5000 million live sperm.

43.5.4 Collection of Embryos

Embryos are normally collected on day-6 to day-8 after onset of estrus, since before this time there is a possibility that they may still be in the oviduct. The embryos are collected by Foley catheter and collection technique is shown in Fig. 43.5.4.1.

For embryo collection in sows are carried surgically by way of a mid-ventral laparotomy under general anesthesia induced by the barbiturate, and usually maintained with halothane using a closed circuit system. The reproductive tract is exteriorized with manipulation the oviducts and uterine horns kept to a minimum. Oocytes are collected after flushing the tube from the uterotubal junction through the cannulated infundibular end of the oviduct with 20-30 ml of warm flushing fluid. The flushing medium is introduced into the oviduct, and ova are collected.

The volume of the fluid is recovered by flushing is allowed to stand at 37°C for 30 to 45 minutes. Approximately 30 ml of the medium is withdrawn from the bottom of the test tube by a sterile Pasteur pipette. It is placed in ova collecting dishes and examined under a stereoscopic microscope.

Non-surgical Method

Early attempts at non-surgical collection of swine eggs had very limited success, which may be due to the length and nature of the sow's cervix and uterine horns appeared to rule out the possibility of using non-surgical recovery procedures.

43.5.5 Evaluation and Morphology

The gross morphological evaluation of embryos to be transferred is useful for estimating pregnancy rates and successful embryo transfer. The sterile petri dishes containing the flushing media are examined under a dissecting microscope with a magnification of 10 to 80x. When ova are found, they are examined in greater detail under higher magnification to determine the stages of development and quality. The embryos are examined individually at 50x to 80x magnification. The highest pregnancy rates 75 to 85% can be achieved with embryos classified as excellent. The first cleavage in pigs occurs about 20 h after the initial fertilization events and the second embryonic cycle takes about 12 h.

The embryos are examined for quality for transferring to recipients. It is obvious that the best results can be achieved with embryos classified as excellent or good and a considerable

drop in results can be expected with fair and poor embryos.

43.5.6 Manipulation of Embryos

Micromanipulation has brought about new dimension in animal reproduction. Production of identical piglets by embryos splitting has become possible through micromanipulation techniques.

Embryo Bisection

Few identical twin piglets have been produced after transfer of bisected pig embryos (Polge, 1985, Nagashima *et al.*, 1988b, Ash *et al.*, 1989). Further exploitation of this technology to produce identical twin piglets would benefit the pig industry because of the facilitated implementation of specific breeding strategies, but could also benefit basic biomedical research. The identical piglets have been used in reciprocal organ transplantation studies serving as a model for human pancreas transplantation. They proved to be extremely valuable as no rejection of the respective graft occurred.

Production of Group of Identical piglets

Experiments have proved that when a single blastomeres derived from 4-cell and 8-cell embryos (1/4, 1/8) can give rise of normal blastocysts and normal piglets have been obtained after transfer of blastocysts derived from cultivated blastomeres originating from 8-cell embryos (Saito and Niemann, 1991). There is a great potential of obtaining small groups of identical multiplets through proliferation of single blastomeres from porcine embryos.

Parthenogenesis

The development of an oocyte without the genetic contribution of a spermatozoon is called parthenogenesis and potentially provides a good method for obtaining large number of identical multiplets. In pigs, electric pulses have been shown to be more effective at induction of parthenogenetic development than is ethanol.

43.5.7 Sexing of Embryos

Many research groups are working in this field since it is considered to be important in the further development of embryo

transfer in pig breeding programs and for the export of embryos. Many techniques are being used for sexing of embryos, but the procedure is yet to be standardized.

Sexing of embryo has been accomplished by karotyping and by the use of antibodies to H-Y antigen attached to a fluorescent probe. Both male and female (H-Y positive and H-Y negative) embryos can be diagnosed with about 85% accuracy. Other methods for sexing the embryos includes Cytological methods, Quantification of differences in metabolic activity between male and female embryos, measurement of glucose-6-phosphate dehydrogenase activity and use of Y chromosome specific DNA probe. The sexing of embryos still needs considerable research to achieve an acceptable accuracy and before its application on a larger scale can be envisaged.

43.5.8 Culture of Pig Embryos

The pig embryos can be cultured from the one-cell stage to blastocyst in a simple HEPES-buffered medium in air. It has been demonstrated that glutamine can serve as a sole exogenous energy source for development of pig zygote to the blastocyst stage in vitro. Beckman and Day (1993) demonstrated that pig embryos could be successfully cultured past the four cell block stage in Whitten's medium, which has a relatively low concentration of NaCl.

43.5.9 Storage of Pig Embryos

43.5.9.1 Short Term Storage of Pig Embryos

The international transportation of pig embryos was recorded by Niemann (1989), the embryos were transported at 36.5°C in 0.25 ml plastic straws held in culture medium enriched with serum. After a 30-34 h journey from Germany in a thermos container, most embryos were viable and gave birth to piglets on transfer in Argentina.

Storage in oviduct of Rabbit

The culture in oviduct of rabbit permits normal embryonic development, when those were later transferred to gilts. The pig embryos would continue developing when transferred to the ligated oviducts of oestrous and pseudopregnant rabbits. A

high survival rate (90%) was achieved when embryos were incubated in the rabbit for 2 days were re-transferred to recipients.

43.5.9.2 Long-term Storage of Swine Embryos

Freezing of swine embryos has not successful in pigs as in cattle and sheep. The pig morulae are more sensitive to cooling below 15°C, due to the high lipid content. Scientists reported that pig embryos at the expanded and hatched blastocyst stage have a higher tolerance to cooling compared with early blastocysts or morulae. The freezability of perihatching-stage blastocysts was confirmed by freezing to -210°C, using 1.5 M dimethyl sulphoxide (DMSO) as a cryoprotectant.

The freezing of perihatching-stage pig blastocysts and their subsequent storage in liquid nitrogen was reported by two Japanese groups (Kameyama *et. al.*, 1990; and Kashiwazaki *et. al.*, 1991). The development of best method of freezing with high transfer rate is still in experimental stage, and the development of an effective procedure for the freezing of pig embryos could have many practical implications and could be expected to result in a significant impact on pig development around the World.

43.5.10 Synchronizing Oestrous

The host or surrogate mother is called a recipient. Synchronization of estrous is the process of bringing groups of animals into heat together in response to some form of treatment. The excellent success or high conception rate after transfer depends upon the synchronization on the estrous cycle of the donor and the recipient. Recipients must be at the same stage of the estrous cycle as the donor. Asynchrony between the donor's and the recipient's estrous cycles of one day results in pregnancy rates similar to those with exact synchrony. Polge (1982) showed that there was no reduction in pregnancy rate when donors were 1 day earlier than recipients but transfers to recipients more advanced than donors did result in a decrease.

43.5.11 Embryo age at transfer

Transfer of 3-7 day old embryos gave a 75% pregnancy

rate, but those attempted on days 8 and 9 were less successful. Pregnancy would not be maintained unless the recipient pig receives at least 4 embryos.

43.5.12 Embryo Transfer Technique

43.5.12.1 Non-surgical Embryo Transfer

Polge and Day (1968) showed that it was possible to achieve a pregnancy after a non-surgical approach, but the success rate was very low (1/32 attempts), which may be due to the anatomy of the sow's cervix in which the small openings of the cervical rings, which are located eccentrically in the caudal half of the cervix, make it very difficult to introduce a catheter into the uterus. However, Galvin *et.al*, 1994 reported the birth of live piglets from gilts following non-surgical embryo transfer with a pregnancy rate and litter size of 21.7% and 4.3.

The non-surgical equipments includes, a modified commercial AI spirette which is used to produce a cervical lock, stainless steel tubing with a curved tip that can be manipulated over the folds of the cervix, testing bar to ensure that the tip of part, reaches the bifurcation of the uterus, and a disposable tubing complex for delivery.

43.5.12.2 Surgical Embryo Transfer

Mid-ventral laparotomy

Recipient sows are penned without access to food and water for 24 to 36 hours prior to surgery. The surgical approach is quite simple and takes about 30 minutes. Following mid-ventral laparotomy under general anesthesia the reproductive tract is exposed. After exposure of the reproductive tract, embryos can be transferred either to the oviduct or uterus depending upon the stage of embryonic development. When transferring to the oviduct the embryos are picked up in about 0.2 ml of fluid in a fine Pasteur pipette which is threaded down the lumen via the fimbula to a depth of about 5 cm. For transferring embryos to the uterus, a small puncture is made in the isthmus region of oviduct about 2 cm from the tip of the horn and the tip of the pipette is slid down into the uterine lumen through the utero-tubal junction.

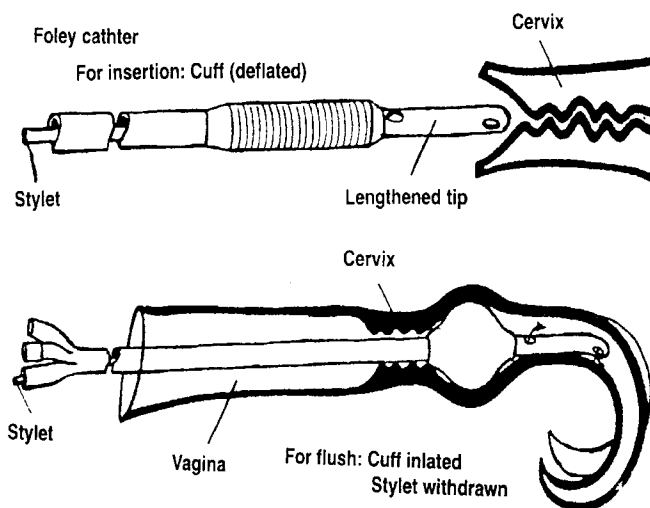


Fig.43.5.4.1 Collection of embryos in pigs.

In surgical embryo transfer in pigs, Galvin *et. al.*, 1994 found a pregnancy rate of 63% and litter size of 7.1.

Apart from the normal problems encountered with all surgery and anesthesia, these surgical techniques are time-consuming and require a great input of human resources.

43.6 Pregnancy Diagnosis

The pregnancy in sows is confirmed by ultrasonic pregnancy detector after 25-30 days of transfer of embryos.

43.7 Future Developments

Improvements in embryo transfer technology have been quite considerable in recent years, and in future, it should soon be feasible to recover much higher number of embryos per donor, sex them and split them as often as required. The achievements made in embryo transfer to date are phenomenal and progress continues to be made in the field, providing us with useful tools in increasing pork production.

1. The embryo transfer technology is a fascinating technique, offering many possibilities of application.
2. Embryo transfer can accelerate genetic process in pig breeding programs.
3. Embryo transfer can be an important research tool to study reproductive biology in pigs, such as fertilization, implantation and the maternal recognition of pregnancy.
4. It also permits the banking of selected types of germ plasma in the shape of embryo. This would provide diploid material of wide genetic diversity to be maintained while intensive breeding and selection programs are conducted.
5. The micro-manipulation of the oocyte prior to fertilization can potentially produce homozygous diploid offsprings.
6. The female counterpart of androgenesis potentially could be achieved by removing a fertilizing sperm and preventing the second polar body from extrusion so it could combine with the oocyte and only female offspring would be born.
7. The injection of the genetic material into the nucleus offers an avenue for injecting genetic material affecting disease resistance.

44. PORK PROCESSING INDUSTRIES

44.1 Meat Processing Industries

Meat processing encompasses all methods by which fresh meat are rendered suitable for cooking, consumption and storage. Although various methods of processing have been used from the earliest times, the modern meat processing industry is one of the results of the development of meat processing technology. In recent times, the new markets for processed meat and meat products have been created by the shifting of the rural population to urban areas, the economic status and the purchasing power of consumers, increase in population and gradual change in eating habits. The processed meat products are in many instances more economical from the standpoint of preparation time, waste associated with preparation and economics. Variety is important and is valued as a factor in improving the diet.

44.2 Meat-Highly Perishable Product

Meat being a highly perishable product, can be kept in a fresh condition only through proper processing and storage. Once an animal is slaughtered, and its flesh is particularly prone to decomposition by proteolytic and lipolytic bacteria. Meat become suitable as food only after some period has elapsed after the death of the animal. Certain biochemical changes take place that make it possible for meat to reach a peak of flavour and texture. Immediately after slaughtering, the meat is soft, shapeless and flaccid. It is less attractive from the aesthetic point of view. Soon after death certain apparent changes take place in the structure and the meat becomes stiff, hard and defined shape, this process is called rigor mortis. After 24 to 48 hr., the stiffening is resolved and the meat again becomes soft and tender. The texture becomes more pleasing and so does the aroma. This is called ripening the meat. If, the keeping is extended, the progressive autolysis, which is an automatic breakdown of the tissue through enzymic action, combines the bacterial activity and causes the meat protein to split into peptides and amino acids. Gradually the meat surface becomes slimy, off flavors and appear and finally objectionable odour become noticeable.

and meat become unfit for consumption. Among the other several factors responsible for the spoilage of meat are microorganisms, air, light and enzymes. The presence of bacteria in large numbers in meat causes off flavors, discoloration and decomposition. Moulds develop into objectionable visible growths and also produce undesirable odour and flavors. The action of air on meat leads to discoloration, rancidity in the fatty tissue and dehydration. Exposure to light fades certain pigments in meat and promotes rancidity, while the enzymes present in meat cause hydrolytic changes. Meat can be preserved in number of ways such as refrigeration and freezing, curing, smoking, dehydration, canning and irradiation. In, India most of the meat is consumed in the fresh form as it is preferred by most consumers. About 1 % of the meat is converted into processed meat products. The pork is only preserved on a commercial scale in bacon factories and processed into ham, bacon and sausages.

There is a need to place the emphasis on the nutritional aspects of processing and preservation of meat and meat products. The majority of meat products are processed to improve their digestibility and to enhance their appeal to the consumer, to extend the shelf life and increasing food security.

44.3 Bacon and Pork Processing

With the introduction of eight bacon factories set up in the country during the Fourth Five Year Plan in public sector, a beginning had been made to organize the pork industry on modern lines.

<i>Installed capacity of Bacon Factories</i>	<i>No. of pigs/ day</i>
Government Bacon Factory, Aligarh (U.P.)	100
Bacon Factory, Harringhatta (West Bengal)	50
Bacon Factory, Gannavaram (Andhra Pradesh)	50
Government Bacon Factory, Kanke (Bihar)	50
Meat Complex, Alwar (Rajasthan)	100
MAFCO Bacon Factory, Mumbai (Maharashtra)	50
Bacon Factory, Koothatukulam (Kerala)	50
Pork Processing Plant, Kharar (Punjab)	50

There is a marked change in pig production due to the introduction of organized development on scientific lines. This had also helped to remove to some extent the prejudice against the pig, which is considered in India an unclean animal.

These factories have been established under the piggery development programme with the dual objective of providing a remunerative market for pig farmers and for the production of wholesome pork and a variety of pork products under hygienic conditions.

The bacon factories are still producing ham, bacon and sausages and other pork products except the one in Rajasthan, has been converted into meat complex and is also producing products from the meat of sheep and goats.

However, these bacon factories are not functional as per their installed capacity. Some of the bacon factories like Kharar (Punjab), Aligarh (UP) has been closed due to unavoidable reasons. There is an urgent need to restart these factories for providing remunerative price to the pig farmers.

44.4 Private Sector Pork Processing Plants

In addition to this some small pork processing units in private sector are also functioning under Meat Food Products Order, 1973. The bacon factories and these units produce fresh pork, bacon, ham, smoked products, sausages and canned pork products. Directorate of Marketing and Inspection, Faridabad, which is under control of Ministry of Agriculture is providing licence for processing of pork and pork products. At present there are about 150 such units in India, which are likely to be increased due to establishment of more piggery farms.

45. HYGIENIC HANDLING AND INSPECTION

45.1 Transport of Pigs

When pigs have to be transported long distances over poor roads, losses from death can be increases.

The stress factor, coupled with over-loading and hot weather can cause losses of 2 to 5 % of the pigs during transportation.

Pigs going direct for slaughter within a few hours of leaving farm may be kept on fasting at least for 12 hours before slaughter. Plenty of water should be provided during that period.

45.1.1 Vehicles or Means of Transport

Every means of transport should be so constructed that:

- (a) pigs can be loaded and unloaded easily;
- (b) pigs of different ages are physically separated during transport;
- (c) soiling by excreta deposited on the vehicle floor is minimized by the use of floor gratings or similar devices;
- (d) ventilation is adequate;
- (e) pigs conveyed on the lower deck of a vehicle or railway or truck having more than one deck are to be protected by an impervious floor below the grating of the upper deck: and
- (f) it is easy to clean and disinfect.

45.1.2 Maintenance of conveyances

Every means of transport used to convey pigs to a abattoir should be maintained in a sound state of repair. They should also be maintained in a clean and sanitary condition by cleaning and if necessary disinfecting as the pigs have been unloaded therefrom.

45.1.3 Transportation during Hot or Cold weather

When trucks are used for transport in cold weather, tarpaulin over and along the sides of the truck will considerably reduce the hazards. In hot weather, water should be thrown over the hogs at stops en-route, will prevent death loss. They should also be sub-divided in small groups.

The best time for transportation of pigs is early morning or evening, when it is coolest.

45.2 Pig Abattoir

45.2.1 Construction Requirements

At the time of construction of new pig abattoir, following points should be considered:

- (a) Abattoirs and establishments should be located in areas not subject to regular and frequent flooding and free from objectionable odour, smoke, dust or other contaminants.
- (b) Abattoirs or establishments should provide adequate working space for the satisfactory performance of all operations.
- (c) The construction should be sound and ensure adequate ventilation, good natural or artificial lighting and easy cleaning.
- (d) The building and facilities of the abattoir or establishment should be kept in good repair at all times.
- (e) The abattoir or establishment should be laid out and equipped so as to facilitate proper supervision of meat hygiene including performance of meat inspection.
- (f) The abattoir or establishment should be of such construction as to protect against the entrance and harboring of insects, birds, rodents or other vermin.
- (g) In every abattoir or establishment there should be a physical separation between departments in which edible and inedible material is handled.
- (h) In all rooms in an abattoir or establishment other than rooms provided for the accommodation of workers and inspectors:
- (i) Floors should be of water-proof, non-toxic, non-absorbent materials, easy to clean and disinfect. They should be non-slip and without crevices and, except in the case of rooms where meat is frozen or stored frozen, should slope sufficiently for liquids to be drained off to trapped outlets protected by a grill.
- (ii) Walls should be of water-proof, non-toxic, non-absorbent materials, which are easy to clean and disinfect, smooth, and at a height appropriate to the operation conducted; they should be light coloured and washable. The angles between the walls and the angles at the wall to floor junctions should be coved.

- (iii) Ceilings should be so designed and constructed as to prevent the accumulation of dirt and condensation and should be easy to clean.

Efficient Effluent and Waste Disposal System

Abattoirs and establishments should have an efficient effluent and waste disposal system which should at all times be maintained in good order and repair. All sewer systems must be large enough to carry peak loads. All lines must be water tight and have adequate traps and vents.

Disposal of waste should be effected in such a manner as to avoid contamination of potable water supplied. The effluent lines and the manner of waste disposal should be approved by the controlling authority.

Abattoirs should include the following:

- (a) services.
- (b) Covered accommodation large enough to house the pigs or where climatic conditions permit, suitable uncovered holding facilities.
- (c) Adequate and well equipped areas reserved for the use of the meat inspection services.
- (d) Lairage and Yards

The lairages and yards should be suitably constructed and maintained, paved or slatted, well drained and furnished with an adequate piped water supply.

Sufficient waterline connections with adequate water pressure should be available to enable the lairages, yards, races and unloading ramps and pig transport vehicles to be cleaned.

- (iii) There should be a sufficient number of paved or slatted pens to facilitate ante-mortem inspection and there should also be covered restraining devices such as chutes, squeeze gates, boxes or any other effective device for restraining pigs requiring close examination.
- (iv) Lairages and yards should be of such a layout that cross traffic of pigs of different species is avoided.
- (v) Where the climate is suitable, washing facilities for pigs prior to slaughter should be available.

- (c) Separate facilities for the physical isolation of sick pigs or pigs suspected of being sick. These facilities should be covered if climatic conditions require this and should be lockable. The drains of these pens should not connect with any of the open drains running through the remaining lairages and yards.
- (d) Slaughter and dressing rooms which enable the work to be performed in a satisfactory manner. A special area should be reserved for pigs where appropriate. If other classes of pigs are slaughtered or dressed at the same time as pigs, facilities for scalding and dehairing of pigs should be situated in an area separated from other areas.
- (e) A separate room for emptying and cleansing the digestive organs.
- (f) A separate room for the further preparation of emptied and rinsed digestive organs.
- (g) If necessary separate facilities for the preparation of edible fats and if they are not removed daily from the premises facilities for their storage.
- (h) Separate rooms for the storing of hides, horns and hooves and inedible pig fats unless these are removed daily from the abattoir.
- (i) Refrigerated rooms suitable for the effective cooling and storage of meat.
- (j) Special facilities capable of being locked solely for the slaughter of suspected pigs. These facilities should be located within easy reach of the pens reserved for isolation.

Meat passed as being fit for human consumption in this room should be conveyed to the edible section of the abattoir or establishment in such a manner as to prevent its contamination.
- (k) Separate facilities in the form of a separate room or portion of a room capable of being controlled and capable of being locked, as required, for storing suspect meat and designed so as to prevent the risk of contaminating other meat and the risk of substitution.
- (l) Room capable of being locked and suitable for the secure

holding of condemned meat, unless other adequate arrangements for disposal exist.

- (m) Facilities for the control of the entrances and exits of the slaughter premises.
- (n) Suitably located facilities for the adequate cleaning and disinfecting of vehicles.
- (o) Specially arranged location for the deposit of manure and adequate arrangements for its disposal.

Cutting Room Facilities

Establishments in which meat is boned-out and cut-up should include the following:

- (a) Adequate and well equipped areas reserved for the use of the meat inspection services.
- (b) Refrigerated room or rooms for the holding of meat.
- (c) Rooms, temperature controlled, for banning and cutting, physically separated from other rooms. Boning, cutting and primary wrapping should be separated from packaging operations. However, meat may be packed in the room where it is boned, cut up and wrapped, provided precautions acceptable to the controlling authority are taken to prevent contamination of the product.

However, the controlling authority may approve other systems in the light of technological developments which will ensure that contamination is prevented to an equivalent extent.

Refrigeration facilities

The construction and lay-out of any chilling room, freezing room, freezer store or freezer should satisfy the requirements as per MFPO (1973).

45.2.2 Sanitary facilities and controls -

- (a) Those operations which carry a risk of contamination of meat human consumption should be sufficiently separated from other operations risk of such contamination.
- (b) Rooms, equipment and utensils provided for slaughtering and dressing should be used for this purpose only and not for boning-out, cutting-up, holding or other handling of meat.
- (c) Abattoirs and establishments should be laid-out and equipped

so as to that meat does not come into contact with floors, walls or other fixed structures, those which are specifically designed for contact with meat.

(d) Slaughtering rooms should preferably be fitted with equipment enabling pigs to be bled and carcasses to be dressed in a hanging position.

(e) Abattoirs and establishments should be equipped with an overhead rail for transporting meat so installed as to prevent contamination of the meat.

(f) Water Facilities

An ample supply of potable water under adequate pressure should be provided with adequate facilities for its storage and distribution and with adequate protection against contamination and pollution. All water used in abattoirs and establishments should be potable. Non-potable water may be used for such purposes as producing steam, refrigeration and fire control. Such water should be carried in completely separate lines, identified preferably by colour. An adequate supply of hot and potable water should be available at all times during working hours.

(g) Adequate natural or artificial lighting should be provided throughout the abattoir or establishment. Light bulbs and fixtures suspended over meat in any step of preparation should be of the safety type or otherwise protected to prevent contamination of meat in case of breakage.

Ventilation System

(h) Adequate ventilation should be provided to prevent excessive heat, steam and condensation and ensure that the air of premises is not contaminated with odour, dust, vapor or smoke. Ventilation openings should be screened. Windows should be fitted with whole panes and those which open should be screened. The screens should be made so as to be easily movable for cleaning. Internal window sills, if present, should be sloped to prevent use as shelves.

(i) All doors should be sufficiently wide and those opening from departments where edible material is handled, unless provided with an effective and operating air screen, should

be solid, as far as practicable self-closing, or snug-fitting double action doors.

- (j) All stairs located in any room used in any department where edible material is handled should be so constructed that: They can be easily cleaned and no contamination can be caused by material passing through the risers of the treads. They should have side curbs that are at least 10 cm in height measured at the leading edge of the treads.
- (k) Platforms, ladders, chutes and similar equipment in any room used for the preparation of meat should be constructed so as to be capable of being effectively cleaned and should consist of material which is resistant to fracture, abrasion or corrosion and which can be effectively cleaned.
- (l) Where chutes are provided they should be constructed with inspection and cleaning hatches.
- (m) All rooms used for slaughtering, dressing, de-boning, preparation, packing or other handling of meat should be equipped with adequate facilities for washing hands, furnished with waste pipes leading to drains and conveniently located for the use of personnel during operations. The water used for the washing of hands should be warm, and taps of hand-washing facilities should be of a non-hand operable type. An adequate supply of odorless liquid soap or other cleansing agents should be provided.
- (n) All rooms used for slaughtering and dressing, boning, preparing, packing or other handling of meat should be equipped with adequate facilities for cleaning and disinfecting implements, conveniently located for the use of personnel during operations. These facilities are for use exclusively in the cleaning and disinfection of knives, steels, cleavers, saws and other implements.
- (o) All facilities for cleaning and disinfecting implements should be of such nature and size as to permit proper cleaning and disinfection of implements. These facilities should be constructed of corrosion-resistant materials and should be capable of being easily cleaned.

- (p) All facilities for cleaning and disinfecting of implements should be fitted with suitable means of supplying water in sufficient quantity at a temperature of not less than 82°C at all times while pigs are being slaughtered or dressed or meat is being handled in that part of the abattoir or establishment.

45.2.3 Equipment and Utensils

All equipment, implements and utensils used in abattoirs or establishments which come in contact with meat should present a smooth impervious surface and be resistant to corrosion and should be made of a material which is non-toxic, does not transmit odour or taste, smooth, free from pits, crevices, non-absorbent and capable of with standing repeated exposure to normal cleaning and disinfection. Stationary equipment should be installed in such a manner as will permit easy access and disinfection. Such equipment should be so constructed that may be easily cleaned.

Equipment and utensils used for inedible or condemned materials should be so identified and should not be used for edible products. Equipment and utensils for slaughtering and dressing should be used for this purpose only and not for cutting-up or boning-out or further preparation of the meat.

No containers, wooden crates, wooden boxes or cartons, should be assembled in parts of an abattoir or establishment where pigs are slaughtered or dressed, or where meat is cut up or boned, prepared, handled, packed or stored. No containers, equipment, or utensils should be stored in any part of an abattoir or establishment where pigs are slaughtered or dressed, or where meat is cut up or boned-out, prepared, handled, packed or stored unless required for immediate use in that part.

45.2.4 Hygienic Operating Requirements

Amenities provided for the use of employees and the meat inspection service including the meat inspection office space should be kept clean at all times.

All equipment, implements, tables, utensils including knives, cleavers, knife pouches, saws and containers should be cleaned at frequent intervals during the day, and immediately

and thoroughly cleaned and disinfected whenever they come in contact with diseased material, infective material or become contaminated. They shall also be cleaned and disinfected at the conclusion of each working day. The manager should ensure that washing down, cleaning and disinfection are carried out in compliance with MFPO (1973).

Carcases or meat should not be contaminated during cleaning or disinfection of rooms, equipment or utensils. Where any skip or trolley or any container used in a department where edible material is handled enters an area where inedible material is handled, it should be cleaned and disinfected immediately before re-entering any edible department.

Detergents, sanitizing agents and disinfectants should conform to public health requirements and should not be allowed to come into contact with meat. Any residue of these cleaning agents used for the washing of floors, walls or edible product equipment should be removed by thorough rinsing with potable water before the area or equipment is again used for handling meat. Prior to use of the equipment any residue of sanitizing agents or disinfectants should be removed by thorough rinsing with potable water.

No cleaning preparation or material, or any paint likely to contaminate meat should be used in any abattoir or establishment where any pig is or may be slaughtered or dressed or meat is or may be prepared, handled, packaged or stored.

Except as required for purposes of hygiene no substance which may contaminate meat should be handled or stored in any part of any abattoir or establishment in which pigs are slaughtered or carcasses dressed or in which meat is prepared, handled, packed or stored. However, materials employed in the construction or maintenance of an abattoir or establishment may be used at any time when an inspector is satisfied that there would be no danger of contamination of meat.

Pest Control

(a) An effective and continuous programme for the control of insects, bird rodents or other vermin within the abattoir or

establishment should be maintained.

- (b) Abattoirs or establishments and surrounding areas should be regularly examined for evidence of infestation with insects, birds, rodents or other vermin.
- (c) Should pests gain entrance to abattoirs or establishments approved eradication measures should be instituted. The eradication of pests should always be carried out under skilled supervision and with the full knowledge of the inspector.
- (d) Only pesticides approved for use in an abattoir or establishment by the competent authority should be used in an abattoir or establishment and the greatest care should be exercised to prevent any contamination of the meat. Pesticides should only be employed if other precautionary methods cannot be used effectively.
- (e) Before pesticides are applied, all meat should be removed from the room and all equipment and utensils covered. After spraying, the equipment and utensils should be thoroughly washed prior to being used again.
- (f) Pesticides or other toxic substances should be stored in separate locked room or locked cabinets and dispensed or handled only by authorized and properly trained personnel. Every precaution should be taken to avoid contaminating meat.

No pigs other than pigs for slaughter should be allowed to enter in any part of an abattoir, except those pigs which are used for transporting and delivering pigs for slaughter or delivering meat. No pigs are allowed to enter establishments.

45.2.5 Operating Practices and Requirements

- (a) Every slaughter pig must undergo ante- and post-mortem inspection.
- (b) No pig should be slaughtered or dressed in any abattoir or establishment except when an inspector is present.
- (c) Any pig in an unreasonably dirty condition should be cleaned to the satisfaction of the inspector before it is allowed to enter the killing floor, so as to lessen the risk of contamination.
- (d) All pigs brought into rooms for slaughtering should be

slaughtered without delay.

- (e) The bleeding should be as complete as possible. If blood is intended to be used in food preparation, it should be collected and handled hygienically and should in no case be stirred with the hand but only with hygienically acceptable implements.
- (f) Stunning, sticking and bleeding of any pigs should not be allowed to proceed at a rate faster than that at which the carcasses can be promptly accepted for dressing.
- (g) The sticking, bleeding and dressing should be carried out with care so as to ensure the production of a clean carcass, head and edible offals. None of the parts should come in contact with the floor and all contamination should be avoided.
- (h) Carcasses should be separated from each other to avoid contact and contamination once the removal of the hide, skin or pelt has commenced. Separation of carcasses, heads and viscera should be maintained until they have been examined and passed by the inspector. Carcasses should come in contact only with surfaces or equipment essential to handling, dressing and inspection.
- (i) Before the removal from any head of any meat or brain intended for human consumption, the head should, except in the case of pigs, be skinned then thoroughly washed and rendered clean with running potable water to the satisfaction of the inspector.
- (j) Where the tongue is dropped it should be done in such a way that the tonsils are not cut.
- (k) The following points should be noted in operations:
 - (i) The handling of carcass of pig should be in such a manner as to avoid contamination of the carcasses. Pumping of air between the skin and the carcass to facilitate skinning should be forbidden. Pigs should be scoured of all bristles, scurf and dirt and may be skinned or partly skinned. The water in the scalding tanks should be changed as frequently as practicable.

- (ii) The carcasses should not be washed in a manner which will allow water to enter either the abdominal or thoracic cavities prior to evisceration.
- (iii) Lactating or obviously diseased udders should be removed from sows. Removal of such udders should take place at the earliest appropriate time during dressing. No secretion should be allowed to contaminate the carcass and therefore udders should be removed in such a manner that teat and udder substance remains intact and without any milk duct or sinus being opened.
- (l) Evisceration should be effected without delay.
- (m) During dressing the following should be observed:
 - (i) The discharge of any material from the oesophagus, paunch, intestines or rectum, or from the gall bladder, urinary bladder, uterus or udder should be effectively prevented.
 - (ii) Any offals intended for human consumption should be removed from the carcass in a manner that will prevent contamination of the organ removed.
 - (iii) Intestines should not be severed from the stomach during evisceration and no other opening should be made during evisceration into any intestine, except as necessarily required by a dressing procedure. The removal of stomach and intestines should be carried out without separation.
 - (iv) Spermatoc cords and pizzles should be removed from the carcass.
 - (n) No carcass, meat or edible offal should be washed in any abattoir other than with running potable water.
 - (o) No paper, cloth, wad, sponge or brush should be used in the washing of any carcass. However, this will not apply with respect to the use of brushes in the dressing of singed pig carcasses.
 - (p) No person should, whether by mechanical or any other means, inflate with air any carcass, meat or edible offal unless ritual procedures require the inflation of lungs.
 - (q) No hides, skin or pelts should be washed or defleshed or left in any part of the abattoir or establishment used for the

slaughtering or dressing of pigs or the preparation or holding of any meat intended for human consumption.

- (r) All stomachs and intestines and all inedible material derived from the slaughtering or dressing of pigs should be removed as soon as possible but in accordance with the inspection procedure from the dressing room in such a manner as to avoid contaminating the floor and walls or any carcase, meat or edible offal.
- (s) All stomachs, intestines and all inedible material should subsequently be treated in parts of the abattoir or establishment destined for this purpose in accordance with recognized practices which should pay attention to cleanliness and hygiene.
- (t) Fecal and other objectionable matter contaminating carcasses during dressing should be carefully trimmed off.
- (u) Where the inspector considers that the manner in which pigs are being slaughtered or dressed or under which the carcasses or meat are being handled, prepared or packaged, will adversely affect
 - (i) the cleanliness of the carcase or meat; or
 - (ii) the hygiene of production; or
 - (iii) the efficiency of meat inspection,

He may require the manager to take action to correct the deficiency or to reduce the rate of production or to suspend operations for the time being in any specified section of the abattoir or establishment.

- (v) In abattoirs, post-mortem inspection should be performed immediately after slaughter. Prior to the final examination, all parts required for inspection of the slaughtered pig should remain identifiable with the carcase and no part must be removed without consent of the inspector.

Branding of meat passed for human consumption

- (a) Meat which has been passed by the inspector as fit for human consumption should be branded according to the requirements contained in MFPO (1973).
- (b) Brands and stamps bearing the marks of inspection should

be kept clean while in use. They should be held in the custody of the inspector and used only under his supervision.

- (c) Only firebrands or suitable branding ink should be applied to the meat.

45.2.6 Operating practices

Operating practices following post-mortem inspection including storage should include following points:

- (a) Meat passed as fit for human consumption should be handled, stored or transported in a manner that will protect the meat from contamination and deterioration.
- (b) Meat passed as fit for human consumption should be removed without undue delay from the dressing area. It should be placed under refrigeration under close supervision of the inspector. However, it is permitted to carry out pre-rigor cutting-up and boning. In this event, the meat should be transported directly from the slaughter-hall to the cutting-up and boning rooms. These rooms should be temperature controlled and situated near to each other in the same establishment. Cutting-up, boning and packing should be done without delay and immediately thereafter the meat should be transported to chilling rooms or to the processing rooms.
- (c) The following provisions should apply where carcasses, parts of carcasses or edible offals are placed in chilling rooms, Freezing rooms or Frozen storage as the case may be:
 - (i) Entry should be restricted to personnel necessary to carry out operations efficiently.
 - (ii) Doors should not be left open for extended periods and should be closed immediately after use.
 - (iii) No chilling room, freezing room or freezer store should be loaded beyond its designed capacity.
 - (iv) Where refrigerating equipment is not manned, automatic temperature recorders should be installed.
 - (v) If no automatic device is installed temperatures should be read at regular intervals and the readings recorded in a log book.

- (vi) A record should be maintained of all meat placed in or taken out of the chilling room, freezing room or freezer store.
- (d) Where carcasses, parts of carcasses or edible offals are placed in a chilling room for chilling, the following provisions should also be observed:
 - (i) There should be a reliable method of monitoring the chilling of carcasses or edible offals which are placed in a chilling room for chilling.
 - (ii) Meat should be hung or placed in suitable corrosion-resistant trays, in a manner permitting adequate circulation of air around the meat.
 - (iii) Meat should be held in a manner which precludes drip from one piece falling on to any other piece.
 - (iv) Temperature, degree of relative humidity and air flow should be maintained at a level suitable for the preservation of meat.
 - (v) Condensation should be prevented by the efficient operation of refrigerating facilities combined with proper insulation of walls and ceilings, the application of heat near the ceilings, or by any other suitable method. If overhead refrigerating coils are installed, insulated drip pans should be placed beneath them. All floor type refrigerating units should be placed within curbed and separately drained area unless located adjacent to floor drains.
- (e) Where carcasses, or parts of carcasses, or edible offals are placed in a freezing room for freezing, the following provisions should be observed:
 - (i) Meat which is not in cartons should be hung or placed on suitable corrosion-resistant trays in a manner permitting adequate circulation of air around the meat. Cartons should be stacked to permit adequate circulation of air around each carton.
 - (ii) Meat which is not in cartons should be held in a manner which precludes drip from one piece of meat falling on to any other piece.
 - (iii) Where meat is held on trays care should be taken to avoid contact between the base of any tray and meat stored beneath.

- (iv) Refrigerating coils should be defrosted frequently to prevent excessive accumulation of ice and loss of refrigerating efficiency. Provision should be made for its removal, without affecting the product, of water resulting from defrosting.
- (f) Where carcasses, or parts of carcasses, or edible offals to be stored are placed in any freezer store the following provisions should also be observed:
 - (i) No meat should be placed in a freezer store until the mean temperature of the meat has been reduced to an acceptable level.
 - (ii) Meat should not be stacked directly on the floor but should be placed on pallets or on dunnage. Stacks of meat in carcass form or in cartons should be placed so that there is adequate air circulation around the stacks.
 - (iii) The freezer store should be operated at a temperature which will give adequate protection to the type of product. Temperature fluctuations in the freezer store should be kept to a minimum. Where unpackaged meat is stored, the temperature difference between the evaporator and the meat should be kept to a minimum.
- (iv) Refrigerating coils should be defrosted as required to prevent excessive accumulation of ice and loss of refrigerating efficiency.

45.2.7 Veterinary Supervision and Hygiene Control

All aspects covered by MFPO (1973) should be supervised by an official veterinarian. In particular, care should be taken that for every abattoir or establishment at least one official veterinarian is appointed for the supervision of hygiene including meat inspection.

It is desirable that each abattoir or establishment in its own interest designates a single individual, whose duties are preferably divorced from production, to be held responsible for the cleanliness of the abattoir or establishment. His staff should be a permanent part of the organization or employed by the organization and should be well trained in the use of special cleaning tools, methods of dismantling equipment for cleaning

and in the significance of contamination and the hazards involved. A permanent cleaning and disinfection schedule should be drawn up to ensure that all parts of the abattoir or establishment are cleaned appropriately and that critical areas, equipment and material are designated for cleaning and/or disinfection daily or more frequently if required.

45.2.8 Laboratory Control Procedures

In addition to the routine control carried out by the meat inspection services, it is desirable that each establishment in its own interest should have access to laboratory control. Analytical procedures used should follow recognized or standard methods in order that the results may be readily interpreted.

45.2.9 Packaging and Packing Material

If the meat is packaged or wrapped, the following considerations should be taken into account:

- (a) Packaging material should be stored and used in a clean and sanitary manner.
- (b) The wrapping should be sufficient for the purpose of protecting the meat from contamination in the conditions under which it is to be handled or transported.
- (c) The wrapping should be non-toxic and should not leave harmful deposits of any kind on the meat, or otherwise contaminate it.
- (d) The wrapping or covering of warm or cold meat transported within an establishment or from one establishment to another should be optional, but care should be taken that the meat is not contaminated.
- (e) Cases or cartons used for the packing of meat should be provided with a suitable inner liner. However, the liner may not be required if individual pieces of meat, such as cuts or boneless meat, are individually wrapped before packing.

45.2.10 Transportation of Meat

- (a) Meat should not be carried in any means of transport which is used for conveying live pigs.
- (b) Meat should not be carried in the same means of transport as other goods in a way which may adversely affect the meat.

- (c) Stomachs should only be transported when thoroughly cleaned or scalded, and heads and trotters only when scalded or dehaired.
- (d) Meat should not be placed in any means of transport which has not been cleaned before loading and if necessary also disinfected.
- (e) Carcases, sides and quarters, other than those which are adequately wrapped and frozen, should be hung during transport or placed in a suitable manner on racks or similar equipment.
- (f) Means of transport or containers should comply with the following conditions:
 - (i) All internal finishes should be made of corrosion-resistant material, be smooth, impervious and easy to clean and disinfect, Joints and doors should be sealed so as to prevent the entry of pests and other sources of contamination.
 - (ii) The design and equipment should be such that the required temperature can be maintained throughout the whole period of transport.
 - (iii) Vehicles intended for the transport of meat should be equipped in such a manner that the meat does not come into contact with the floor.
 - (iv) Suitable closed containers should be used for the transport of unwrapped edible offal. Offal should be transported under refrigeration unless the period transport is less than two hours.
- (g) Every effort should be made to prevent changes in temperature of frozen meat at any time during storage and transport but where accidental thawing takes place the meat should be examined and evaluated by the inspector before any further step is taken.

45.2.11 Meat unsuitable for human consumption

- (a) Meat being condemned or otherwise unfit for human consumption should forthwith be placed in clearly identified chutes, containers, trucks, trolleys, skips, or rooms, or other adequate arrangements provided for these purposes and held under the supervision of the inspector. For the purpose of

clear identification, cuts or brands may be made to show this meat is condemned or unfit for human consumption. The transport of such meat to the rendering station should be performed to the satisfaction of the inspector to ensure that no removal of such meat is possible and no contamination could be caused by such meat.

- (b) No person should remove or cause to be removed from any abattoir or establishment, any carcase, meat, organ, viscera or fat that has been condemned or retained by the inspector, except under his direction and supervision.
- (c) Where in any abattoir or establishment any carcase, meat, organ, viscera or fat is found to be unsuitable for human consumption, it should be the duty of the manager to cause the carcase, meat, organ, viscera or fat to be removed to a by-products plant in accordance with the rules of the controlling authority.

45.2.12 Hygiene and Health of Personnel

45.2.12.1 Facilities for Personnel

Every abattoir and establishment should include the following amenities:

1. Facilities for employees

Adequate changing room accommodation, drying room, lunch room, toilets with flushing water closets, showers and hand-washing facilities to any work areas. Hand-washing facilities with hot and cold water with taps of a non-hand operable type and suitable electric dryer should be provided adjacent to every toilet.

2. Facilities for meat inspection personnel

Adequate changing room accommodation, drying room, lunch room toilets with flushing water closets, showers and hand-washing facilities. The amenities reserved for the meat inspection service, and toilets should have adequate lighting, ventilation and heating. Hand-washing facilities with hot and cold water with taps of a non-hand operable type and suitable hygienic means of drying the hands should be provided adjacent to every toilet.

Office accommodation should be provided for the exclusive use of the meat inspection service. Laboratory facilities should be readily available for the purpose of meat inspection and meat hygiene.

45.2.12.2 Personnel Health Management

Following points should be taken into consideration for management of health of the personnel.

- (a) Managers of abattoirs and establishments should arrange for adequate and continuing training of every employee in hygienic handling of meat and clean habits so that the employees are able to take the necessary precautions to prevent contamination of meat. Instructions should include relevant parts of MFPO (1973).
- (b) It is recommended that national legislation should provide for a medical examination of meat handlers, meat inspectors and other persons who come into contact with meat in abattoirs and establishments. This medical examination should be carried out just prior to employment and should be repeated when clinically indicated.
- (c) The management should take care to ensure that no employee, while known or suspected to be suffering from or to be a carrier of a disease capable of being transmitted through meat, or while afflicted with infected wounds or sores or diarrhoea, is permitted to work in any area of an abattoir or establishment in a capacity in which there is a possibility of such a person directly or indirectly contaminating meat with pathogenic micro-organisms. Any ill person should immediately report to management that he is ill.
- (d) Any person who is cut or injured should discontinue working with meat and until he is suitably bandaged should not engage in any abattoir or establishment in the preparation, handling, packaging or transportation of meat. No person working in any abattoir or establishment should wear any exposed bandage unless the bandage is completely protected by a waterproof covering which is conspicuous in colour and is of such a nature that it cannot become accidentally detached.

- (e) The manager of any abattoir or establishment should, if required to do so by an inspector, produce for perusal by the inspector any medical certificate produced to the manager by an employee of the abattoir or establishment.
- (f) Every person engaged in an abattoir or establishment should wash his hands frequently and thoroughly with soap or detergents under running warm potable water while on duty. Hands should be washed before commencing work, immediately after using lavatory, after handling contaminated material, and whenever else necessary. After handling diseased or suspect material hands must be washed and disinfected immediately. Notices requiring hand-washing should be displayed.
- (g) Every person engaged in an area in an abattoir or establishment where meat is handled should maintain a high degree of personal cleanliness while on duty, and should at all times while so engaged wear suitable protective clothing including head covering and footwear, all of which articles should be washable unless designed to be disposed of and which should be maintained in a clean condition consistent with the nature of the work in which the person is engaged. Aprons and similar items should not be washed on the floor.
- (h) Every person who visits an area in an abattoir or establishment where carcasses or meat are handled should wear clean protective clothing.
- (i) No part of an abattoir or establishment used for slaughter of pigs, dressing of carcasses, preparation, handling, packaging or storing of meat should be used for deposit of personal effects or clothing.
- (j) Protective clothing, knife pouches, belts and working implements should be deposited in a place provided for the purpose where they will not contaminate any carcase or meat.
- (k) Any behavior which can potentially contaminate the meat, such as eating, use of tobacco, chewing, should be prohibited in any part of an abattoir or establishment used for slaughtering or dressing of carcasses or for the preparation, handling,

packaging or transportation of meat.

- (1) Gloves if used in the handling of meat should be maintained in a sound, clean and sanitary condition. The wearing of gloves does not exempt the operator from having thoroughly washed hands. Gloves should be made of an impermeable material.

45.3 Pre-slaughter Handling and Inspection

Every slaughter pig should:

- (a) be appropriately identified or ensure that the place of origin.
- (b) be adequately rested prior to slaughter in clean, well ventilated lairages and yards having drinking troughs supplied with potable water.
- (c) undergo an ante-mortem and post-mortem inspection.

45.4 Ante-mortem Inspection

45.4.1 Objectives

The objectives of ante-mortem inspection are:-

- (a) to select pigs which are adequately rested and which will provide pork which is fit for human consumption;
- (b) to select for isolation and detailed clinical examination, suspected diseased or suspected abnormal pigs;
- (c) to prevent contamination of the dressing areas by pigs in an excessively dirty condition;
- (d) to prevent contamination of premises, equipment and personnel by pigs suffering from a disease which is communicable;
- (e) to obtain information which may be necessary for the post-mortem inspection, diagnosis, and judgment of carcase and offals.

45.4.2 Prerequisites for ante-mortem inspection

- (a) No pig should proceed for slaughter until the inspector has carried out an ante-mortem inspection and has passed the pig for slaughter. Exceptions may be made in cases of emergency slaughter.
- (b) All pigs should be inspected within 24 hours of delivery to the abattoir. If the pig is kept for more than 24 hours after the initial ante-mortem inspection at the abattoir the ante-mortem

examination should be repeated on the day of slaughter.

- (c) The method of identification of inspected pigs should be approved by the controlling authority.
- (d) It is the duty of the management of the abattoir to present the pigs in such a way that an adequate ante-mortem inspection can be carried out.

45.4.3 Ante-mortem inspection procedure

- (a) Pigs should be inspected in a standing position and in motion, and while they are not excited.

(b) The following should be observed:

- (i) abnormalities and signs of disease;
- (ii) behavior of pigs in sick or suspected disease condition.
- (iii) observe for age, colour and specific markings;
- (iv) cleanliness of slaughter pigs.

(c) Particular attention should be paid to the following details:

- (i) manner of standing and movement;
- (ii) state of nutrition;
- (iii) reaction to environment;
- (iv) condition of hide, skin, hair and bristles.
- (v) digestive system (salivation, consistency and colour of faeces);
- (vi) appearance of the urino-genital system, including vulva, mammary glands, prepuce and scrotum;
- (vii) respiratory system (nostrils, including mucous membranes, charge, blood tinged froth, quality of respiration);
- (viii) injuries, swelling or edema;
- (ix) body temperature in suspected or obviously diseased pigs.
- (x) blood smear (in cases in which a disease is suspected which could be diagnosed by examining the blood);

Disposition of pig after ante-mortem inspection

The post-mortem inspector should be qualified veterinarian.

A pig is released for slaughter without any restriction when the ante-mortem inspection has revealed no evidence of any abnormal condition or disease. If a condition has been noted that does not prevent the pig from being slaughtered for human

consumption, the pig should be identified, released for slaughter and post-mortem veterinary inspection.

Where disease signs are doubtful, the pig should be withdrawn from slaughter and placed in an isolation pen set aside for this purpose for detailed examination, observation or treatment, or slaughtered under special conditions to preclude contamination of the premises, equipments and personnel.

Where signs indicate a systemic involvement, a communicable disease, or toxicity from chemical or biological agents which may render the pork unsound for human consumption, so affected should be withheld from slaughter and condemned.

Pigs exhibiting normal behavior but known to have been treated or given drugs and to be carrying consequent residues or which are carrying residues from other sources, should be either condemned or withheld from slaughter until the residues are excreted or metabolized by the body to harmless end products. In case of doubt the pig should be identified and slaughtered and the carcase and viscera should be subjected to all necessary laboratory examinations.

Any pig which as a result of ante-mortem inspection is not passed for slaughter should be examined for a final decision on its disposition by the veterinary Inspector.

Pigs which have died and those which have been rejected at ante-mortem inspection and slaughtered, should be removed immediately and rendered into inedible products.

45.5 Post-mortem Inspection

45.5.1 Purpose of post-mortem inspection

The purpose of post-mortem inspection is to ensure the detection of abnormalities and pass the meat which is fit for human consumption. The inspector should carry out routine checks on the manner and methods of handling pigs, stunning, shackling and bleeding.

45.5.2 Prerequisites for post-mortem inspection

1. Before the post-mortem inspection of slaughter pigs is commenced it is the duty of the inspector to satisfy himself

that the condition of the premises, equipment and facilities are conducive to the efficient and hygienic performance of this examination. It is the duty of the management of the abattoir to present the carcasses and viscera in a hygienic manner and in such a way that an adequate inspection can be carried out.

In operating an abattoir the following points should be observed:

(a) Separation

Carcasses should be separated from each other to avoid contact and contamination. Separation of carcasses, heads and viscera should be maintained until they have been examined and passed by the inspector. Meat should come in contact only with surfaces or equipment essential to handling, dressing and inspection.

(b) Evisceration

Evisceration should be effected without delay.

(c) Identification of carcasses and their parts

Prior to the final examination, all parts required for inspection of slaughtered pig should remain identifiable along with the carcass,

(d) Washing of Hands

Every person engaged in an abattoir should wash his hands frequently and thoroughly with soap or detergents under running warm potable water while on duty. Hands should be washed before commencing work, immediately after using the lavatory, after handling contaminated material, and whenever else necessary. After handling diseased or suspect material hands must be washed and disinfected immediately. Notices requiring hand-washing should be displayed.

(e) Cleaning and disinfection of equipments and tools

All equipment, implements, tables, utensils including knives, saws and containers should be cleaned at frequent intervals during the day, and immediately and thoroughly cleaned and disinfected whenever they come in contact with diseased or infective material or become contaminated. They shall also

be cleaned and disinfected at the conclusion of each working day.

45.5.3 General Post-mortem inspection procedure

Routine post-mortem inspection should include viewing, palpation and, where necessary, incision. This inspection should be carried out in a hygienic and systematic manner.

Where a lymph node, organ or any carcase tissue is being incised by the inspector, the cut surface should be cleanly sliced in order to present a picture which is not distorted. Where an incision is required to be made, the inspector should take possible measures to prevent any risk of contamination.

The head, organs, viscera and any other part of a carcase required for post-mortem inspection should be identifiable with the carcase until inspection has been completed.

Except with the permission of the inspector no person should, prior to the inspection of any carcase being completed:

- (i) remove any serous membrane or any other part from the carcase.
- (ii) remove, modify, or obliterate any evidence of disease in the carcase or organs by washing, scraping, trimming, stripping or otherwise treating the carcase or organ.
- (iii) remove any mark or identification from the carcase, head or viscera, until the inspector has completed his inspection and given his decision.

No person should remove from the inspection area of an abattoir any part of any carcase, organ, or any viscera, until the inspector has completed his examination and a decision has been given.

Viscera should be examined:

- (i) as they are removed from the carcase; and/or
- (ii) after their removal from the carcase, in which case they should be clearly identifiable with the carcase until inspection has been completed.

Retention of carcasses and viscera

Any carcase or viscera found to be diseased, suspected of disease or any abnormality which requires a more detailed

examination should be suitably branded and retained under the supervision of the inspector and kept separate from carcasses, viscera and heads which have been inspected.

Where in the opinion of the inspector, a more detailed post-mortem examination or a microbiological, parasitological, chemical or histopathological examination any other examination necessary to render a judgment on a carcase or viscera, is required, he should take all the necessary specimens from such carcase or viscera.

The final responsibility as to the decision on fitness for human consumption rests with the veterinary inspector.

45.5.4 Detailed Post-mortem inspection of Pigs

Inspection of heads of pigs

(a) The surface of the head as well as the oral and nasal cavities should be viewed.

(b) The sub-maxillary lymph nodes (*lymphonodi mandibulares*) should be incised and the cut surfaces examined.

The parotid (*lymphonodi parotidei*), and retropharyngeal lymph nodes (*lymphonodi retropharyngei*), should be incised if necessary.

(c) Where *C. cellulosa* is prevalent, the outer muscle of mastication and the root of the tongue should be incised, and the blade of the tongue viewed and palpated.

(d) The tonsils should be removed if necessary.

(e) The head should be split lengthwise if necessary.

Inspection of viscera

The following viscera should be examined:

(a) Gastro-intestinal tract

Viewing of stomach and intestines and if necessary palpation. Viewing, palpation and if necessary incision of associated lymph nodes. These lymph nodes should be incised if any lesions have been observed in the submaxillary lymph nodes.

(b) Spleen

Viewing, and if necessary, palpation and incision.

(c) Liver and lymph nodes

Viewing and palpation and if necessary incision.

(d) Lungs

Viewing and palpation of entire organ. Viewing and incision of bronchial mediastinal lymph nodes (*lymphonodi tracheobronchiales et mediastinales*), provided they are not obviously diseased. If necessary, an incision should open up the larynx, trachea and bronchi. A transverse incision across the lower part of the diaphragmatic lobe should open up the bronchi.

(e) Heart

Viewing of the heart after the pericardium has been opened, and incision to expose the cardiac valves if necessary. Where *C. cellulosa* is prevalent, the opening up of the heart and a deep incision into the septum should be an inspection procedure.

(f) Uterus

Viewing and, particularly where sows are concerned, palpation and if necessary incision.

(g) Kidneys

Kidneys should be examined for enucleation, and if necessary, palpation and incision.

Inspection of carcasses

(a) The carcass should be examined to ascertain:

(i) condition;

(ii) efficiency of bleeding;

(iii) colour;

(iv) condition of serous membranes (pleura and peritoneum);

(v) abnormalities;

(vi) cleanliness, proper scalding and dehairing;

(vii) odour.

(b) The skeletal muscles, including the attached fat and connective tissue, the bones, especially those which have been cut and exposed during the splitting of the carcass, the joints, the tendon sheaths, the diaphragm and the pleura and the peritoneum, should be viewed and if necessary palpated and incised.

(c) The site of castration should be palpated and if necessary

palpated and incised.

(d) The following lymph nodes should be viewed, palpated and if necessary incised:

(i) superficial inguinal (supra-mammary) (*lymphonodi inguinales superficiales*);

(ii) iliac (*lymphonodi iliaci*);

(iii) renal (*lymphonodi renales*).

(e) When a systemic or generalized disease is suspected to exist, the main carcase lymph nodes should be examined.

(f) Measures should be taken in meat inspection system to protect the public adequately from trichinosis.

Disposition and Branding

(a) Carcases, heads, organs and viscera which as a result of ante- and post-mortem inspection are passed as fit for human consumption without further restrictions should be appropriately branded.

(b) Any meat, heads, organs and viscera which require treatment by heat or by freezing to render them fit for human consumption should be suitably branded and kept under supervision of an inspector until the necessary treatment has been concluded and the carcase can be passed as fit for human consumption.

(c) All carcases, parts of carcases, organs and viscera which as a result of ante- and post-mortem inspection are found to be unfit for human consumption, and foetuses, should be held securely to the satisfaction of the inspector until they are branded, stained, rendered, denatured or otherwise destroyed, so excluding them from human food purposes.

(d) The size, shape, and wording of any brand, as well as the colour and composition of marking ink used for the branding of carcases and organs, should be laid down by the controlling authority and should be uniform throughout the country.

Laboratory Examination

(a) Laboratory facilities should be readily available to provide the veterinary inspector with the information necessary to judge whether the meat is fit for human consumption.

- (b) Samples should be properly identified and accompanied by fully explanatory information.
- (c) Care should be taken to ensure that samples arrive at the laboratory in good condition.
- (d) Laboratory methods to be used should be such procedures as are scientifically recognized.

46. PORK PROCESSING AND STORAGE

46.1 Pork Processing Technology

46.1.1 Fresh Pork

The fresh pork is produced in slaughter house and a plan of slaughter house for 20-30 pigs/day is given in Fig. 46.1.1.1.

46.1.1.1 Pre-slaughter Handling of Pigs

Pigs are more susceptible to transport stress, which may affect the quality of pork and pork products. The factors for the weight loss may be many such as initial body condition of the animal, crowding, overloading, season, duration of journey, mode of handling and transport.

Water sprinkled from overhead on the restraining passage helps to calm pigs down. This also helps in cleanliness of pigs before slaughter. Pigs arrive at slaughter house are placed in the lairages for resting for 12 to 24 hours, to avoid the effect of stress. Stress severely affect the quality of pork, thus producing pale, soft and exudative and dark, firm and dry pork.

46.1.1.2 Slaughtering of Pigs

Stunning

Pigs are highly susceptible to stress. Autoelectric stunner, which is highly transistorized according to shape and size of pigs function quite satisfactory. The electrodes should be properly placed on either side of the head at horizontal line of the ears, the electrode pad should be dipped in to weak saline solution to improve conductivity through the skin. The voltage of stunner is 80 Volts 50 cycles and 50 milliamperes. The electrodes should be applied to minimum period of 10 seconds, the animal become unconscious for one minute. Pigs should be shackled elevated and stuck immediately after stunning. A time of 10-20 seconds should be achieved after removal of electrode to improve bleeding and minimize blood splash.

Sticking

The sticking knife should be inserted on the center line of the throat in front of the breast bone and then pierce through heart. The knife should not go in so far as to penetrate the shoulder. The stick cut should be as small as possible to reduce

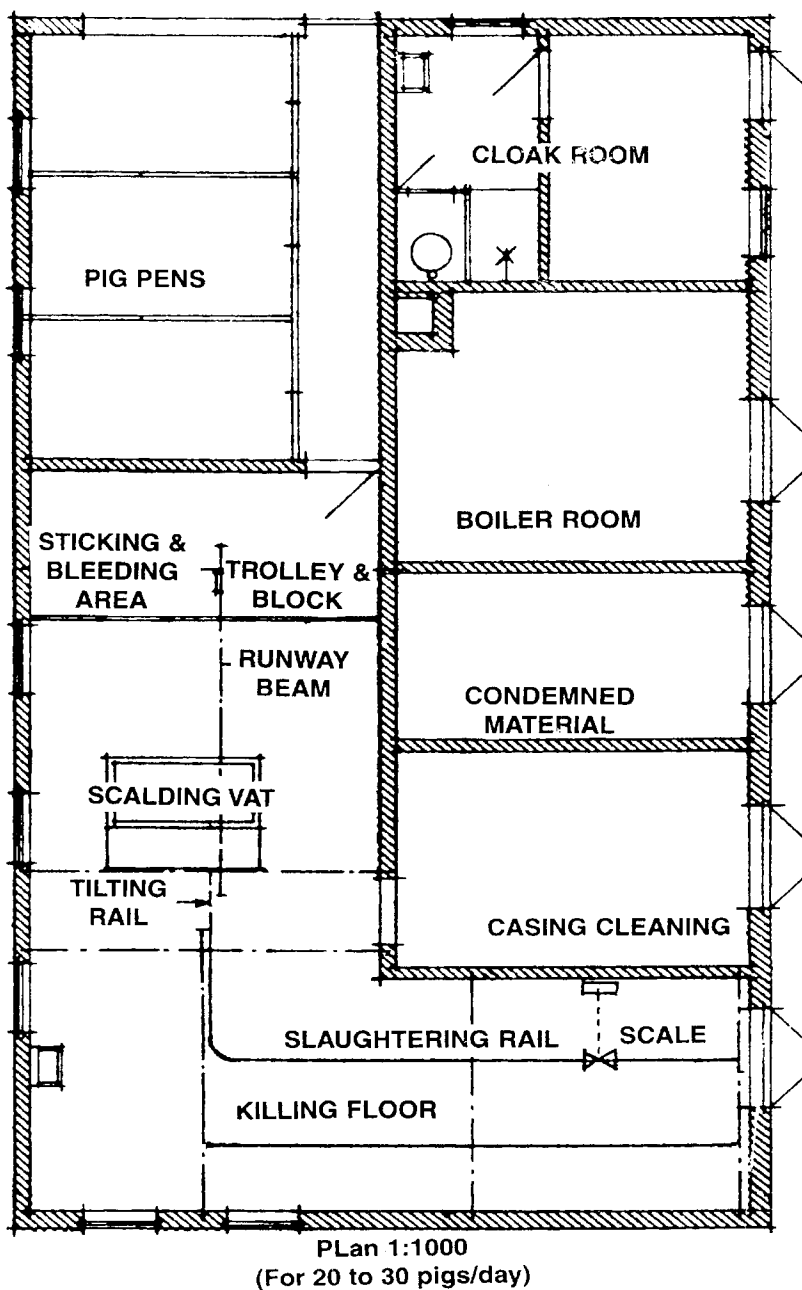


Fig. 46.1.1.1 Plan of Pig Slaughte House.

the ingress of dirty scalding water. The bleeding time is about 3 minute.

Bleeding

The bleeding is complete by 6 minutes and pigs are sent to scalding tank. Depending upon the weight of the animal 2.5 to 3.6 kg blood is obtained.

Scalding

This is necessary to remove pig hair from the follicle, and also surface sterilization of the carcass. It is done by dipping the carcass in the scalding tank having the water. The time temperature parameters are 5.5-6.5 minutes from 61°C to 59°C.

Dehairing

It is done in simplest form by a specially formed hand scrapper. Machines of various sophistication are also used. It is U shaped machine. The dehairing not only removes the hairs but further improves the finish of the carcass.

Finish

Still hairs are removed by scraping and brushing is done.

Gambrel

The carcass is placed on the gambrelling table leaving dehairing machine.

Singeing

If bacon is to be cured from the carcass singeing is done for 15 seconds, it removes remaining hairs, sterilize the cuticles and improves the keeping quality.

Evisceration

The intact whole carcass is washed, Head is cut and dropped. The aitchbone is split to prevent the contamination from the guts. The belly is opened, the stomach and abdominal mark is removed and placed separately from pluck for post-mortem examination.

Cutting

The carcass is split longitudinally down to the center of the spinal cord from the aitchbone to the head and sent to the chillier. The different parts of the carcass are shown in Fig. 46.1.1.2.1.

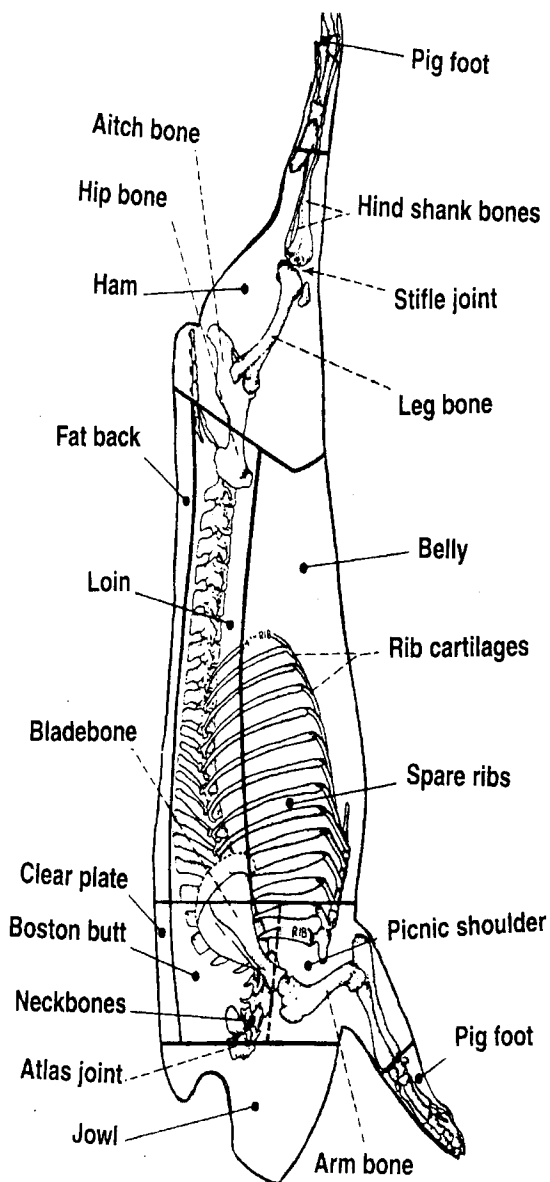


Fig. 46.1.1.2.1 Parts of Pig Carcass.

46.1.1.3 Transport of Pork

The hygienic handling and transport of meat has significant value from economic, nutritional and public health point of view. It will also ensure the transportation of meat over long distance and for bridging over the period of scant production. Meat handling and transportation from abattoir to market in hot condition is generally done with rapidly speed. There is hardly any regulations operating regarding hygienic transport of meat. In major cities, the abattoir authority provide covered fly-proof vans to the butchers to transport meat for its distribution from slaughter house to the retail outlets. In small places, every convenient methods are adopted for transport of the meat. The private exporters or State Meat Transport are engaged for the export trade in meat. In every vehicle used for the carriage and delivery of meat the basic hygienic requirements during all stages Of transport should be maintained to prevent meat from spoilage.

Constructional Requirements

The internal transport of meat is done in enclosed vehicles, specially designed to transport meat. The vehicle should be so constructed or covered in as to prevent the access of flies and to exclude dirt and dust. The roof should be finished internally with a material that can be easily cleaned. The covering of all sides of the platform type of vehicle should be waterproof.

If meat is transported without containers, the floor of the vehicle should be constructed of hard material to prevent the absorption of grease and blood. The floor should have a non-slip surface. Ribbed or studded aluminium alloy flooring is suitable for this purpose, as to facilitate drainage, combines strength with lightness and is easy to clean. Galvanized sheeting, also gives the satisfactory results.

The walls of the vehicles should be lined with flush, non-corroding panels, the joints between each panel being adequately sealed to form a smooth surface, To simplify cleaning the angles are eliminated by covering the junctions of the walls, floors. Zinc, aluminium alloys and galvanized sheet are more suitable lining of interior walls. Non alloyed aluminium can be used

after painting. Duckboards or racks should be sectional and if wooden should be made of hard wood. They must be kept clean and in a good state. Metal racking is stronger, more durable and more easily cleaned,

Design and cleaning of vehicles

Vehicles acquired for transporting carcass meat should be specially designed for the purpose. Other vehicles should be adapted for hygienic transport of meat. Carrier Vehicles of other goods should be properly cleaned before meat is loaded.

The vehicles, containers and equipments Should be properly cleaned at regular intervals. An ample supply of hot and cold water, hose pipes, detergent, bass or wire brooms and buckets should be available at slaughter houses and bacon factories to enable thorough cleaning of vehicles.

Loading and Unloading of Carcass Meat

The process of loading and unloading should be carried out in such a way that the meat is not soiled. Vehicles with specially constructed low slung chassis have advantages for some specialized operations. The loading and unloading operations should be carried by experienced personnel. Mechanical loading devices minimize handling and the need for walking on the floor of the vehicle,

Transport of certain types of meat

Meat which is not adequately wrapped should be hung. Containers for use with un-frozen offal should be fashioned so as to exclude contamination from the floor of vehicles and loading yards to make for easy cleaning. Metal containers are best as it can be cleaned as soon as the offal has been taken out. Raw meat, offal and casings should not be allowed to come into contact with open pack meat products.

Delivery from Butcher to consumer

The meat should be adequately wrapped or in covered containers. If covered containers are not available, it should be carried in suitable metal or plastic trays. The special care should be taken to protect meat and meat products from contamination during transport.

Personal Hygiene

A high standard of cleanliness in the handling of meat should be maintained by all persons engaged in its transport. The hands are important in the spread of food poisoning organism from the handler to meat and from meat to the handler. The bacteria on the hand can be passed to cloths, and other equipments. The handlers can add germs to meat from their hands soiled by excreta from the bowel and by secretions from the nose or throat. The care of hand is important. In bacon factories and slaughter houses, there should be good facilities for hand-washing.

All persons engaged in the handling of meat should wear suitable protective clothing made of material which can be easily washed and kept clean. The clothing should be so designed as to give adequate protection both to the wearer and the meat. Persons carrying on their shoulders carcasses or quarter of meat should wear protective covering. Light coloured cotton caps or shoulder pads covered with impervious material are useful adjuncts. Protective clothing should be clean. Good habits should be encouraged. Illness even if minor, should be reported particularly if there is diarrhoea, vomiting, sore throat or skin infection.

Proper handling and personal hygiene prevents the contamination of meat by bacteria during transport. The chances of bacterial food poisoning, zoonotic diseases could be prevented by careful handling and transport of meat at all stages of production and at retail shops.

46.1.2 Processed Pork Products

The primary purpose of processing is to prevent pork from spoilage. The methods by which pork can be preserved are drying, curing, cold, heat, chemicals and irradiation. Processing not increases the shelf-life of pork products, but also increases the taste and organoleptic qualities.

46.1.2.1 Methods of Processing

Salting

The empirical observation that salting would preserve meat without refrigeration was made several thousand years ago. Salt is not only a preservative, but also a flavoring substance. Its preservative effect is enhanced in conjunction with sodium or potassium nitrites. Nitrates are primarily used to develop colours, although they have some bacteriostatic effect also. The various forms of salted pork, which are widely regarded as attractive, continue to be extensively prepared. Curing is done either by pickling or dry curing. The curing rooms are usually maintained at 1.7° to 4.4°C. Curing in pickle may be with plain pickle (salt solution), in pickle containing nitrate and/or nitrite, or in pickle to which sugar as well as nitrate and or nitrite (sweet pickle) and other ingredients have been added. Same ingredients are used in dry curing. Pork cuts like ham, bacon and shoulder cuts are used for preparing cured products.

Wiltshire Cure (Bacon cure)

After slaughter, the carcass is singed and scraped and sides are trimmed. The trimmed sides are chilled to 3-7°C. The brine (pickle) is pumped into the sides. The sides are either sprinkled with dry salt or placed in a tank of brine and then the sides are removed and stacked for some time in a maturing cellar at 3-7°C for 7-14 days or longer. During this period, known as maturation, the sodium chloride, the nitrate and nitrite become more evenly distributed throughout the musculature and the typical colour and flavour is developed. A relatively recent development in the preparation of bacon is sliced curing. This process gives a uniform product in less than a day instead of 10-21 days of, the traditional process.

Ham

The pig carcasses are quickly cooled after slaughter and two days later curing is begun. The brine is injected by arterial pumping (6 percent of the weight of the ham). The hams are kept covered in brine for two to three days. The hams mature on racks for about six days at curing temperature and are deboned,

cut and exposed briefly to cold smoke, then heated and processed in cans.

Dry Curing

In this method, the surface of meat is rubbed thoroughly with the dry curing mixture and then the meat is placed in the vat. Each tightly packed layer of meat is sprinkled with the curing mixture. The bellies may be cured in open vats, or they may be dry cured for a short period, and then pickle cured. After curing, the hams are smoked at regular intervals at about 26.7°C for approximately 30 days and then aged for 7-11 months at ambient temperature.

Emulsion Curing

In processing sausages, emulsion curing has been employed in recent years. This involves cooking the meat emulsion, immediately after adding the curing ingredients, for 90 minutes at 75°C.

Smoking

Smoke, generally produced by the slow combustion of saw dust derived from hard-woods, inhibits microbial growth, retards fat oxidation and imparts flavour to cured meat. Smoked pork and pork products are high calorie products of good eating properties and delicate juicy texture. The smoking causes dehydration and fermentation. Various compounds are known to be found in smoke, The smoke ingredients penetrate into the thickness of the product, impart a specific taste, appearance and colour and odour to it. Smoked products intended for long storage as lower moisture content creates unfavorable conditions for microbial developments.

46.1.2.2 Processing and its effect on Nutritive value

The major part of the meat consumed in India is eaten as unprocessed fresh meat. During the past decade a number of meat processing plants have been established. Introduction of processed meat increases the varieties of choices for specific consumer groups, tourist trade, hotel and restaurants. It would also contribute to the economy of the meat industry.

The effect of processing are normally considered in terms

of their detrimental effects in the nutrient composition of meat. There are, however some beneficial effects. Meat and meat products are processed to improve their sensory qualities, to destroy pathogenic organisms and for preservation purposes.

The detrimental effects of processing on nutritional quality of pork and pork products are - shrinkage and loss in juiciness, loss of nutrients including vitamins and amino acids etc. during thermal processing, freezing and storage.

A significant loss of flavour has been reported, if bacon is stored at 45°F for 4 to 6 weeks. If proper sanitation and hygienic conditions are not maintained during the processing process, even at cold storage meat get spoiled. The spoilage of meat can be prevented by using sanitation in all handling operations, particularly in chilling room. The use of ozone, carbon di-oxide, ultraviolet light and ionizing radiations in storage rooms has been recommended for prevention of spoilage.

Although prediction of nutrient loss is not an easy matter. Imperial studies have shown that because of the close relationship between the factor dependence of quality factors such as colour, texture, vitamins and flavour, processes optimized for organoleptic quality attributes are also optimal for nutrient retention. In recently developed processing methods, the processing loss of nutrients due to well established commercial practices is reduced. These includes microwave thawing and cooling, aseptic canning, irradiation etc.

46.3 Packing of Pork and Pork Products

Packaging ensures the safe delivery of pork and pork products to the consumers. Packaging maintains the quality of pork products, by delaying the onset of spoilage. The proper selection of packaging materials and techniques can help in protection, preservation and successful marketing of pork and pork products.

Fresh Pig Meat

A large quality of pork is sold through butcher's shops after immediate removal from the carcass, increasing quantities are butchered at points remote from the retail outlet. Such pork

may be packed in large “primal” packs for further cutting at the point of sale or it may be cut in to retail size units for direct sale to the consumers. Fresh meat is packed to maintain colour, texture and moisture.

Cellophane coated with nitrocellulose has been used for wrapping fresh meat for long time. The polystyrene trays with a transparent film overwrap allows the satisfactory storage of meat for 10 days at 0°C. Vacuum packaging of fresh meat increases the storage life. Boneless pork and joints are shelf stable for a period of two weeks at 0°C in vacuum packed condition.

Cured meats

The right choice of packaging material is important for packaging of cured meats in order to maintain the colour. Short term storage of cured meats can be done by overwrapping in polyethylene film. Ham and other large uneven cuts of cured meats can be shrink packaged in polyvinyl chloride (PVC) co-polymer. Vacuum and gas packaging is the right choice for long term Storage of sliced bacon in laminate pouches made up of polyester/ polyvinylidene chloride (PVDC) or polyamide or metallized polyamide, Product packaged by this technique has a shelf life of 3 months at 0-4°C and 6 months at -18°C.

Frozen Pork and Pork Products

Frozen pork and pork products are packed in moisture proof cellophane and polyethylene coated polyester, which extends shelf life of frozen pork chops for 3 months.

Precooked frozen Pork products

Hamburger and other pre-cooked frozen pork products are packaged in the boilable bag consisting of polyester/medium density PE laminate. These packaging materials can with stand boiling for about 20 minutes and makes excellent seal.

Thermo-processed Pork Products

A wide range of cured sausages is now prepared and marketed in sleeves of low oxygen permeability. Corned pork and liver sausages are hermetically sealed and processed in metal cans to preserve the desirable flavour, texture, and appearance. Pork luncheon meat and chopped pork are vacuum packed in a

polyester film/ aluminium foil/ polyolefin film laminate pouch autoclaved and put in printed board carton. These packaged products have a shelf-life of 2 years at room temperature.

Economic constrains within the meat processing industry demand the utilization and proper packaging of all possible parts of the carcass in a manner which will yield greatest return both to the processor and the consumer without affecting the nutritional value and quality.

46.4 Increasing Shelf-life

The shelf-life of pork and pork products can be increased by low temperature storage, heat treatment, modified atmosphere packaging, irradiation etc.

46.4.1 Refrigeration

Refrigeration is the simplest method of preservation of meat. Efficient refrigeration can preserve pork in a condition approaching its natural state for periods adequate for commercial requirements. However, its appearance, flavour are little altered, and no substance is added to pork nor any extracted. During refrigeration, heat is extracted from the pork in the cooling chambers and thereby prevention of multiplication of harmful bacteria, yeasts, and molds.

Meat and Fish have long been frozen for preservation by Eskimos and other Northern people. Refrigeration and freezing are the quick and safest methods of extending the shelf life of fresh and processed foods at low temperature. The storage at low temperature prolongs food life by reducing the rate of biochemical and microbiological changes. It provides a maximum retention of taste, flavour, colour and visual attractiveness with the minimum changes to sensory characteristics and nutritional properties of food. The successful and safe preservation of refrigerated and frozen food depends upon the sophisticated equipment, type of technique, packaging etc. The shelf life of fresh food is determined by the type of food, stage of maturity and condition. The shelf life of the processed food is affected by the type of food, control of hygiene, packaging and temperature during distribution and storage.

Refrigerators are designed to store the perishable foods at a temperature of about 4-5°C for a reasonable period of time by chilling.

An optimum refrigeration temperature and relative humidity are essential for pork and pork products to obtain the maximum storage life. Refrigerators are made in different sizes determined by the capacity of the storage cabinet, which is measured in litre.

Advantages of Refrigeration

The refrigeration is the method of reducing the rate of biochemical and microbiological changes to extend the shelf life of fresh and processed pork products. The salient advantages of refrigeration are as follows:

- It is a quick and safest temporary storage of perishable pork under conditions best suited for the retention of freshness, natural flavour and taste.
- It reduces the wastage of pork and pork products.
- It eliminates the chances of contamination and food poisoning.
- It provides storage space at a temperature lower than its surroundings in which pork can be kept in conditions best suited for retention of freshness and nutritive value.
- The refrigerators are designed to store various fresh and processed and ready to eat pork products.

Refrigerators are available in different sizes, models and colour. The technical details vary according to size and make. A reduction in temperature below the minimum which is necessary for microbial growth, prevents or retards reproduction of the microorganism. There are three types of microorganism, based on the temperature range for growth:

- (i) Thermophilic (35-55°C)
- (ii) Mesophilic (10-40°C)
- (iii) Psychrophilic(-5 to -15°C)

Refrigeration of pork prevents the growth of thermophilic and many mesophilic microorganisms. Chilling to temperature below 5- 7°C, therefore retards microbial spoilage and prevents

the growth of pathogenic microorganisms. Refrigeration also reduces the rate of enzymic and microbial change in pork.

One common problem of low temperature storage is that of dehydration of food stuffs due to moisture condensation. This can be overcome through use of appropriate packaging materials.

Micronutrients, minerals and most of the vitamins are not much affected at refrigerated temperatures.

Refrigeration, cannot improve the quality of decayed porks, it can only retard deterioration. An optimum refrigeration temperature and relative humidity are essential for pork products to obtain the maximum storage life. Recommended storage temperatures and storage life for selected foods are as follows:-

Storage Temperature & Life for Selected Pork

	Temperature °C	Time
Fresh pork	38	3 Days
Ham	38	1-2 Weeks
Cured Bacon	38	1-2 Weeks

Home Storage of Pork and Pork Products

Fresh, cured and ready to eat pork are highly perishable foods. These may be safely stored at refrigerated temperature just above freezing (1 to 2°C) for a short period. Meat once purchased for use must be handled with great care to prevent exposure to contamination from air, equipments and utensils. Ground pork should be used within 24 hours of purchase. The pork and pork products are best stored at the coldest part of the refrigerator i.e. just below the freezer. Packaging of meat helps to protect the meat from further contamination and drying. Fresh pork should be wrapped in waxed paper or aluminium foil. Fresh packaged pork can be kept in refrigerator for two to four days. Cooked and processed pork has a shelf-life of 3-6 days at 1 to 2°C. Cured and smoked meat in its original wrappings can be successfully stored for 7 days. Leftover cooked meat dishes should be kept in covered container inside the chiller and should be consumed within 24 to 48 hours.

46.4.1.2 Deep Freezing

Deep freezing is a highly effective and quick method of

long term preservation of food. It is increasing in importance through out the world, specially in advanced countries. Now this method of low temperature storage has also been introduced in developing countries, including India.

Pork may be stored at -18°C , which prevents oxidation and rancidity. The shelf-life of pork at -18°C is 6 months, at -25°C is 12 months and at -30°C is 15 months.

Modern home freezing is useful and applicable to a variety of food and food products, and has proved a highly effective method because of its severely inhibiting effect on spoilage microorganisms. Most of the microorganisms cannot grow at temperatures below 32°F and may be seriously damaged by slow freezing. The freezing point of food is lower than that of pure water and solid freezing usually occurs at temperatures between 32°F and 25°F . The temperature of the food undergoing remains constant until the food is almost completely frozen, then the temperature rapidly approaches that of the freezing medium.

Different type of pork products freeze over a wide range of temperatures, and their specific freezing points are known. Slow freezing forms large, needle like ice crystals, while rapid freezing results in smaller crystals, producing a finer texture. If, partial melting and re-freezing are repeated several times, larger and larger ice crystals are formed, producing a rougher texture.

Deep freezers are usually designed to maintain a temperature range of -10°F to -20°F , a range in which foods remains in a frozen state and can be safely preserved for a long time. The deep freezers usually employ a vapor compression system, with a compressor delivering the refrigerant to an air cooled condenser. The liquid refrigerant from the condenser passes through an expansion valve to the evaporator, which decreases the temperature of the freezer.

The deep freezer is designed to maintain the safe storage temperature of -18°C or under. The modern deep freezer equipment permits the rapid freezing of pork, so as to preserve its natural flavour, texture colour and appearance. Freezing does not improve the quality of the pork and pork products.

Advantages

The main advantages and uses of the deep freezers are as follows:-

- Deep freezing is a convenient and successful method of long term storage of meat and meat products.
- It is also used to store precooked or semi-cooked pork products.
- It is very helpful in transportation of pork and pork products.

The deep freezers are available in different sizes ranging from 85 liters to 425 liters capacities. The 25 liters of the frozen space will accommodate about 8 kg of frozen produce. The careful planning and management plays an important role in maximizing the utilization of the capacity of the freezer.

Chest and Upright Freezers

Freezers are available in two types, chest freezers and Upright freezers. The chest type freezers are available in capacities from 165 to 500 litres. The main advantage of chest freezer is that the cold air is heavier than warm air, there is little loss of cold when the freezer is opened. The chest freezers are excellent for bulk storage of meat and other items, specially in restaurants and hotels and retail counters.

In chest freezer it is easier to accommodate large and oddly shaped packs. The defrosting cycle should be done at least once in a year, if all food is securely packed and the lid is not frequently left open for long periods.

Upright freezers are available with capacities ranging from 85 litres to 275 litres. These are very convenient for preserving different types of food. However, there may be some slight rise in temperature as the door is often left open. The upright freezers require a small floor area, and can be installed at any small room or kitchen. Because of the loss of cold air from the freezer each time the door is opened, and are thought to be less efficient and economical to operate. Some upright freezers have individual flaps at the front of each shelf to protect the contents when the main door is open. Upright freezers are more expensive to buy, but the upright freezers of the same capacity may take half the

floor space than the chest freezers. The door storage enables small items to be easily accessible. The defrosting cycle must definitely takes place atleast twice in a year as temperature fluctuation due to opening of the door causes more frost formation in the cabinet than the chest freezers.

The frozen foods will not be suitable for human consumption for indefinite time. There is a recommended storage time for different types of frozen foods. However, it is the best practice to keep the foods on move and use all the frozen foods before the recommended time limit.

What damages pork and pork products?

Micro-organisms are present in the air, water and on the foods. They are capable of multiply rapidly when conditions are favorable. The vast variety of micro-organisms are harmless. However, some of the micro-organisms are capable of causing spoilage of foods and other whose presence may cause food poisoning and infections.

All micro-organisms require moisture for their growth and multiplication. The absence of available moisture in frozen food significantly affects the growth of the micro-organisms in foods stored at -18°C. Psychrophilic micro-organisms, which require a temperature range of -10 to 20°C for their growth, can cause spoilage in frozen pork.

Storage life of Pork products

Type of Frozen foods	Maximum Storage Time (months)
Pork	4-6
Sausages and minced meat	2-3
Bacon	1

Freezing of Pork and Pork Products

Pork and Pork products can be successfully frozen in the deep freezer for domestic consumption. Both fresh and cooked pork can be frozen. Pork for freezing should be of high quality and should have been aged for the required time. Pork is normally chilled for 1-2 days before freezing. Cooked pork and pork products freeze well with longer shelf-lives than the frozen raw

pork. Rancidity occurs more slowly in precooked pork due to the destruction of the peroxidase in cooking. The sauces and gravies present also acts as a protective agent against oxygen gaining access to the fat in the cooked meat. Cured meats, salted butter and salted products such as bacon do not freeze well.

Preparation of Meat for Freezing:

Packing of meat and meat products is the main factor responsible for the shelf life of the frozen meat. Meat for freezing should be preferably boned. After removal of the surplus fat, it is prepared in the form in which it is to be cooked. One cubic feet of frozen space would store 4 lb. of meat at a time. Since the oxygen in air coming into contact with meat surfaces causes oxidation, which is responsible for spoilage of the meat. Wrapping should be strong and damage to the packages can be padded with grease-proof paper to prevent them piercing the wrappings. Air must be completely excluded so that the freezer wrapping stays close to the meat and prevents drying out. Pack small cuts intended for cooking at one time. Small cuts intended for frying should be packed with foil dividers so that chops can be easily separated without defrosting. Never pack so that you need to defrost part of the contents, then re-freeze the remainder. Overpacking of meat is more necessary, as it is likely to be damaged.

Method of Packing:

The use of 200 gauge polythene film and bags and aluminium foil is the suitable material for packing. Divide the quantities according to the family requirements. Protect any protruding bones with several thickness of grease-proof paper. Squeeze out as much as air as possible and do not permit air pockets to remain, seal with tape, and overwrap with strong polythene or paper.

Thawing of Meat:

Slow thawing maintains the quality of the meat. Meat thawed slowly is considered to be juicer than meat thawed more rapidly, which is due to the longer period for the re-absorption of the juices which were withdrawn from the tissue during

freezing. Thawing in the refrigerator gives the best results. But thawing at room temperature is faster than thawing at refrigerator. Thawing in a microwave oven is the fastest method of thawing. Once the meat is thawed it should be used immediately.

Approximate Thawing Time for Meat (Per 400 g)

Media	Thawing Time
Refrigerator	8 to 10 hours
Room temperature	3 to 4 hours
Cold water	30 to 45 minutes
Microwave oven	6 minutes

Cooking Frozen Meat:

Meat should be cooked as soon as it has thawed, to prevent the loss of juices. The same methods as for cooking fresh meat like roasting, grilling, frying and stewing should be used. Chops and steaks cook best in a thick frying pan lightly oiled, starting with gentle heat on both sides before browning more quickly. Joints are best cooked by slow method of roasting in oven (150 to 180°C).

Effect of Freezing

1. Ice Crystal Formation

Slow freezing forms large needle like ice crystals, while rapid freezing results in smaller crystals, producing a finer texture. If partial melting and re-freezing are repeated several times, larger and larger crystals are formed, resulting a rougher texture of food and food products. The cells of pork contain a jelly like protoplasm. To fix this protoplasm, the rate of cooling must be sufficiently rapid to promote formation of minute, uniform crystals throughout the tissues. When the quick frozen food is thawed, it re-absorbs the water as the ice crystals melt and returns to their original jelly like state. Slow freezing encourages the formation of larger ice crystals, and thawing results the punctured cells which cannot re-absorb all the fluid.

2. Solute Concentration

The increase in the solute concentration during freezing causes changes in pH, and viscosity. Freezing may irreversibly

change colloidal structure, fusing suspended particles as in protein coagulation.

3. Volume Changes

The volume of ice is 9% greater than that of pure water and expansion of foods after freezing takes place. However, the degree of expansion varies due to the moisture content, cell arrangement, the concentration of the solute and the freezer temperature. A suitable headspace must be allowed for in freeze packaging. Not all food products increase in volume. When large amount of sugar are added, expansion is greatly reduced and volume may actually decrease.

4. Freezer Burn and Dehydration

Long storage and poor wrapping may result in the removal of moisture and juices, particularly in meat. This results in grayish brown patches on food, known as "Freezer Burn". Frozen food packaging must provide protection from dehydration resulting from sublimation. Adequate packaging inhibits freezer burn, an irreversible changes in the colour, texture, flavour and nutritive value of the frozen pork and pork products.

5. Oxidation and Rancidity

The oxygen from the air which penetrates wrappings reacts with fat cells in food to form chemicals which gives pork and pork products a bad smell and taste. In poorly packaged meat, where the loss of moisture continues over a long period, the underlying tissue becomes more open and tough. The spongy nature of underlying tissue is more easily penetrated by oxygen and subcutaneous fat may become oxidized and rancid. Salt accelerates this rancidity. Pork fat may become rancid after 6 months storage.

Packaging for Freezing

Frozen food packages have certain specific functional requirements, such as capable of withstanding low temperature, construction from non-toxic materials, convenient and economic. Products are affected in varying degrees by loss of water from their surfaces and some require a good moisture barrier. Pork and other pork products require protection from

oxygen and light. Packaging cannot improve the quality of frozen pork, but the good packaging material will maintain the texture, colour, taste and nutritive value of the pork and pork products.

Packaging Materials

All packaging materials should be moisture and vapor-proof, waterproof and grease-proof, durable and resistant to low temperatures, economic, easily handled and stored and free from smell. Foil is useful for the dishes which are cooked or heated before use. Heavy duty foil is useful for both raw and cooked dishes. It should be used with dull side towards the food. Freezer paper is a strong wrapping which is highly resistant to fat and grease, does not punctured easily and has an uncoated outer surface on which labeling may be done. Special deep freezing tape with gum which is resistant to low temperature must be used for packing sheet wrapped packages and sealing containers with lid. Polythene bags are useful for almost all foods and are available in a wide variety of size and thickness. Polythene sheeting is easy to handling meat and poultry products and transparency helps in identification.

Beneficial Effects of Freezing of Pork

Pork affected with *cysticercus cellulosae* can be rendered safe if held for 4 days at -10.5 to -8°C. *Trichinella* cysts in pork are destroyed by holding the carcass for 20 days at -15°C or by quick freezing for 24 hours at -18°C.

46.4.3 Modified Atmosphere Packaging

When pork and pork products are packaged in an atmosphere other than air to suppress microbiological, chemical and physical changes, the shelf-life is significantly increased. There are 5 key elements that must be considered to achieve the optimum effect of Modified Atmosphere Packaging (MAP), the initial microbiological state of the pork, temperature control, the gas mixture, the barrier film and the packaging equipment.

MAP is not a new technology. Killefer in 1930 showed that pork kept fresh twice as long in 100% carbon-di-oxide at 4-7°C compared with storage in air at the same temperature.

Pork that was vacuum packaged and stored at 4°C showed

good microbiological and sensory qualities. Extended storage of 18-26 weeks was achieved in CO₂ packaged cuts stored at -1.5°C.

46.4.4 Irradiation

The potential use of irradiation in combination with other meat processing has been realized recently. The use of irradiation in combination with packaging and mild heat treatment could result in superior quality and increased shelf-life of pork products. Such products could also minimize the risk of meat borne infections. It also reduce the energy requirements and costs for pork products that are traditionally marketed in a frozen form. In India, this process would be very useful, as facilities for frozen storage and for the distribution of pork products are not widely available.

Advantages

- * A significant increase in the shelf-life.
- * Enhanced microbial safety of fresh and processed pork.
- * Can be applied to individual pork items to ready to eat pork and shelf stable meals.
- * Reduction in the energy requirements for pork processing.

Process

It has been demonstrated that combination of low dose ionizing radiation up to 3 kgy with reduced pH and water activity and addition of organoleptically acceptable acidulants or humectants, substantially increased the shelf-life of fresh meat and meat products in non-frozen state. This technology would result in the saving of energy and in aiding distribution in areas where freezing facilities are not available.

Combination of gamma irradiation 2.5 kgy with dipping in acetic acid or sodium tripolyphosphate solution extended the storage life of meat from 2 weeks to 4 weeks at 0-3°C; from 10 days to 2 weeks at 7-10°C; and from 18 hours to 42 hours at 28-30°C when packed in polythene.

Salami and frankfurters when treated by irradiation combined with nitrite curing had a shelf-life of 2 weeks at 0-

3°C compared with less than 1 week for the non-irradiated products.

A combination of 2 kgy gamma irradiation with reduction of pH to 5.6 and reduction of water activity to 0.960 can extend the shelf-life of vacuum packaged ready to fry minced pork with cereal filling and seasonings to three times.

47. QUALITY CONTROL AND STANDARDS

Meat is defined as the flesh of the animal used as food, it is often widened to include, as well as the musculature organs such as liver, kidney, brains and other edible tissues. The bulk of the meat consumed in India is derived from Sheep, Goat, Cattle, Pigs and Poultry.

The quantity or yield of dressed meat obtained per animal depends largely on its live weight, size, breed, and also on topographical and climatic conditions. The average dressing yield in terms of the original live weight for Indian cattle ranges from 35-40 percent, for sheep and goats 40 percent, and for pigs 60-65 percent. The carcass of the animal is divided to produce cuts. The value of meat depends to a great extent on the appearance and shape of these cuts. The different beef and buffalo cuts are round, rump, sirloin, short loin, flank, rip, short plate, square cut chuck, brisket and shank. Mutton and goat meat cuts are legs, loins, racks, breasts, shanks and shoulders. Pork cuts are ham, shoulders, loins, tender loins, -spareribs, and butts.

47.1 Pork and Comparison with other meat

Fresh meat is usually of a light pink colour, firm and fine in grain, with a smooth velvety touch and is full of sap. The fat is well distributed. On storage meat becomes coarse, dry and stringy, sticky to touch and darker in colour.

Meat from young animals tends to be pale and almost devoid of fat. It may lack flavour but is tender to eat. Flavour depends particularly on fat, due to volatiles that are species distinct and increase during growth. In older animals there is more fat within and between muscles, reducing the tenderness. Best meat is reported to be obtained from sheep, goats and pigs between the age of 6 months and one year, and cattle between one and three years.

According to the species like cattle, sheep, pig, goat, buffalo the meat is differentiated into beef mutton, pork, goat meat, buffalo meat.

Pork

Pork varies in colour according to the age and conditions

of nutrition of the animal and the part of the body. It is generally whitish grey, pale red, pink-red, grey red to dark red. Boiled pork has a very delicate texture and is white in its cut. The flesh is firm and fine, well marbled. The fat is pure white finely granular, soft more oily or greasy to touch than that of beef and mutton. It envelopes the larger groups of muscles and is considerably intermixed with the fibre. The bone marrow is soft and pink red.

Beef

Beef is usually bright red with a raspberry tinge, with a fine grain and velvety to touch. It is well covered on the surface with fat which is considerably marbled. Raw beef has a weak, characteristic odour, which becomes stronger on boiling. The colour of boiled beef is gray in the cut. The fatty tissue is light yellow, hard, and of crumbly consistency. Meat from old and inferior animals is often darker, coarse, fibered and dry, with a more yellowish fat.

Buffalo meat

Buffalo meat is dark red when slaughter warm and becomes bright red on chilling due to formation of oxyhaemoglobin. The muscular tissue is coarsely fibrous. The odour of buffalo meat and fat resembles that of musk and the fat is strikingly white, and is drier and less sticky than in beef.

Mutton

Mutton is light to brick red in colour, bright and glistening. It is moderately firm in consistency having white, hard, clear and abundant fat between the muscles and under the skin. The fat is odorless and tallow like, setting quickly and becoming crisp and firm. Mutton cuts are small and the lean meat is bright pink with a white brittle and flaky fat.

Goat meat

Goat meat is dark red with a brown tinge and coarser in texture. It has a characteristic "Goaty" odour and may have hairs adhering to its surface.

The fat is little yellowish and does not set so firmly as mutton fat.

Rabbit Meat

Rabbit meat is pale, pink and becomes white on boiling.

Horse Meat

Horse meat is darker than meat of other animals. After storing in air, its colour becomes intensely dark red with a blue tinge due to metmyoglobin formation. The fatty tissue ranges from yellow to lemon yellow and has a soft greasy consistency,

Camel Meat

Camel meat is coarse, thick and disagreeably sweet due to presence of glycogen.

Poultry Meat

Poultry meat is firm fine fibered. There is little intermixing of fat with the fibre. The colour is pale to red. The fat is soft and oily.

47.2 Quality of Fresh Pork

The fresh pork is generally whitish grey, pale red, pink-red, grey red to dark red. The flesh is firm and fine, well marbled. The fat is pure white finely granular, soft, more oily or greasy to touch. It envelopes the larger group of muscles and is considerably intermixed with the fibre.

47.2.1 The Eating Quality of Pork

Traditionally, pork has been seen as desirable components of the diet and of high nutritional value. The eating quality of pork will be judged on its merits by the consumers, who will judge from several aspects. The consumer, usually a house wife, buys pork not only for its specific cut, but also on its suitability for children, the specific meal, and the price. The eating quality of pork can be judged as follows:-

47.2.1.1 Colour

The colour of fresh pork is generally whitish grey, pale red to grey red to dark red. The colour varies according to age and conditions of nutrition of the animal. The colour of a freshly cut and exposed surface of meat is due to reduced myoglobin. On exposure to oxygen, myoglobin is converted into oxymyoglobin giving rise to bright red colour, which is desired by the consumers. On further exposure the oxymyoglobin gets

converted into metmyoglobin leading to dark brown colour, The pig meat is very pale due to the relative absence of myoglobin and chemical change in the pig meat. The colour of cooked, uncured lean meat depends upon the nature and mount of myoglobin derivatives. During cooking, the colour of meat changes gradually from deep red to pink to lighter tint.

47.2.1.2 Water-holding capacity and Juiciness

The water-holding capacity of uncooked pork influences the juiciness of meat after cooking. The fall in post-mortem pH reduces the water-holding capacity. Conditioning of pork increases its water-holding capacity.

Juiciness in cooked pork has two organoleptic components. The first is the impression of wetness during the first few chews and is produced by the rapid release of the meat fluid; the second is one of the sustained juiciness. The good quality pork is juicier than poor quality pork.

47.2.1.3 Texture and Tenderness

Texture and tenderness are the most important characteristics which determine the consumer preference. Texture as seen by the eye, the size of the muscle bundles and of the connective tissue envelopes of muscle bundles. The tenderness depends upon the amount of connective tissue present in the muscle portion. The pork contains little connective tissue as compared to other meat. Tenderness is affected by pre-slaughter and post-slaughter factors. The pre-slaughter factors includes breed differences, age at slaughtering, feeding and management practices. The post- slaughter factors include the length of time and the temperature of storage after slaughtering, method of trimming and cutting, method of cooking and the addition of tenderizing agents. Pork stored at 0-5°C after slaughtering, tenderness decreases during the first 24 hours at the setting of rigor mortis and then increases gradually. Freezing and frozen storage have a tendering effect. Pressure cooking increases tenderness with detrimental changes in the biological value of pork proteins. However, no lowering of nutritive value of meat would occur at temperature below 100°C.

The use of artificial tenderizers like vinegar, lemon juice, wine or salt and enzymic tenderizing is not new. It was inadvertently employed at least 500 years ago by the Mexican Indians when they wrapped meat in paw-paw leaves during cooking. Sodium chloride and other salts have a tenderizing action on meat. Pre-slaughter injection of proteolytic enzymes to the live animals has proved to be most effective method of artificial tenderizing. A concentration of about 5 to 10% of tenderizing enzyme is injected half an hour before slaughter at the rate of 0.5 mg/lb. body weight.

42.2.1.4 Odour and Taste

Flavour is a complex sensation, which develops as a result of odour, taste, texture, temperature and pH. The odour and taste varies between the individuals and influenced by extraneous factors. The taste of raw pork is bland, being only slightly sweet, salt sour or bitter.

The fresh raw pork has a slight odour. Meat from young animals has less odour than from the older one. The meat from young animals fed on a feed containing a high proportion of fish meal may have fishy odour. Condition, method and time of storage influences the odour.

Taste and odour of pork develops on cooking and it depends on the method of cooking, type of cut, treatment of meat before cooking and spices used. The flavour of cured pork is better as compared to that of uncured pork. Pork is the most frequently preserved by curing, which improves the flavour of cured pork products.

47.3 Factors influencing the Quality of Pork

There are number of factors which influences the quality of pork. The color of the pork varies according to age and conditions of the nutrition of the animals. The hygienic handling and transport of meat has significant value from economic, nutritional and public health point of view.

A high standard of cleanliness in the handling of pork and pork products should be maintained to control the quality of pork and pork products.

47.4 Quality Control Standards

Meat quality refers to a combination of traits producing an edible product with minimum loss of constituents; without undesirable characteristics after processing and storage; remaining attractive in appearance and appetizing, nutritious and palatable after cooking. In India Bureau of Indian Standard has laid down the classification and grading standards of meat and meat products. The Meat Food Products Order, was established in 1973 to consider the hygiene standard for fresh and processed meat.

47.4.1 Role of Standards in Quality Control

Standard plays an important role in ensuring quality by controlling the whole production process. In all developed countries, quality control of meat and meat products is not only enforced to ensure supply of wholesome meat and meat products, but even system of grading meat based on various parameters exists.

47.4.2 Standards for Pork and Pork Products

“Standardization” implies the establishment of uniform quality specifications between place to place, between one time and another, and between buyers and sellers as a basis for the grades. Specifications should be formulated in precise terms, be agreed upon and made known to all consumers and meat processors and producers.

47.4.3 Grading and Quality Control

The word “Grading” means the sorting of meat into different lots, each with substantially the same characteristics with respect to market quality, and each bearing its own label or name. These characteristics may be size, shape, flavour, degree of ripeness, length of staple or other measurable features affecting the commercial value of the product. Class and grade standards for meat has for their primary purpose the establishment of a system of equitably dividing the normal quality range of pork into smaller unit groups, having similar specific uses as an aid to satisfactory sale and purchase. It also helps buyers to select the most suitable produce for the use they

have in mind. It permits the house-wives to purchase more precisely what they want and are willing to pay for. Grading not only satisfies consumers but also make the pork marketing system more efficient. Pork grading is the visual determination of grades of carcasses with parameters between the percentage of lean meat and back-fat thickness and the assessment of type is subjective grading is the conformation of ham, loin, belly and shoulder as 85% is allocated to determine the type in these four parts.

47.4.4 Bureau of Indian Standards (BIS)

The Bureau of Indian Standards (BIS) is responsible for preparation of Indian Standards for Pork and Pork Products and timely revision as per the consumer preference, market demand, and hygienic conditions and MFPO (1973).

47.4.5 Indian Standards on Pork and Pork Products

The Bureau of Indian Standards (BIS) has prepared many Indian Standards on Pork and Pork Products. Some of the Indian Standards Specifications are on following products are available with BIS.

IS No.	Title	Latest date
IS 1723:1973	Pork (First revision)	Oct 1995
IS 1982:1971	Code of practice for ante-mortem inspection of meat animals (first revision)	Feb 1995
IS 2475:1979	Smoked bacon (first revision)	Feb 1995
IS 2476:1963	Ham	Feb 1995
IS 3060:1979	Pork sausages, canned (first revision)	Feb 1995
IS 3061:1979	Pork sausages, fresh (first revision)	Feb 1995
IS 4352:1967	Pork luncheon meat, canned	Oct 1995
IS 4950:1968	Bacon rashers, canned	Feb 1995
IS 4951:1975	Ham, canned (first revision)	Feb 1995
IS 12542:1988	Canned ham, minced	Feb 1995

47.4.6 Meat Food Products Order

The Meat Food Products Order (MFPO) is being enforced by Directorate of Marketing and Inspection, Government of India, Ministry of Agriculture. It was enforced in 1973 to grant license for manufacture of meat food products in the country. As per this act, no person shall carry on business as a manufacturer except under and in accordance with the terms and conditions of a license granted to him under this order. There are three categories of manufacturers, i.e.

Category 'A'- manufacturer who makes meat food products exclusively from meat of animals slaughtered and dressed in his factory.

Category 'B'- manufacturer who makes meat food products exclusively from meat of animals slaughtered and dressed in slaughter house approved by the licensing authority and whose factory is situated in close proximity to such slaughter house.

Category 'C'- manufacturer who makes meat food products other than those belonging to categories 'A' and 'B'. The constitution of Meat Food Products Advisory Committee is as follows which shall advise the Department of Agriculture and Co-operation in the Government of India dealing with Animal Husbandry on any matter pertaining to Meat Food Products Industry:

Chairman

Agricultural Marketing Adviser to the Government of India, Ministry of Agriculture, Faridabad.

Members

1. Animal Husbandry Commissioner, Government of India or his nominee.
2. Director General of Health Services, Government of India or its nominee.
3. Director General of Technical Development, Government of India, or his nominee.
4. Executive Director, Food and Nutrition Board, Ministry of Food and Civil Supplies, Government of India or his nominee.
5. Director, Central Food Technological Research Institute,

Mysore or his nominee.

6. Two persons from among the manufacturers to be nominated by the Central Government.
7. An officer of the Directorate of Marketing and Inspection to be nominated by the licensing authority who shall act as the Secretary of the Committee.

A member of the committee shall hold office for the period for which the Committee has been constituted.

47.5 Quality Control for Export

There is an urgent need to adopt International codes, HACCP System in order to maintain quality control for export of pork and pork products.

47.5.1 International Codes

The Joint Food Standards Programme, CODEX ALIMENTARIUS COMMISSION formed by Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) is recommending International Code of Hygienic Practice for Fresh and Processed Meat Products, for quality control for export of pork and pork products. This code of Hygienic Practice applies to fresh meat intended for human consumption, whether by direct sale or for further processing. It contains the minimum requirements of hygiene of meat production from slaughter of animals up to and including transport of meat and is intended to assure a healthful and wholesome meat supply.

47.5.2 HACCP System in the Pork Industry

Food borne disease outbreak is continuously increasing in the World. Among the outbreaks *Salmonella*, *Staphylococcus aureus*, *vibrio parahaemolyticus* were the most important etiologic agents and meat and meat products were the most notorious. Hazard Analysis Critical Control Point system is a process control system, designed to identify and prevent microbial and other hazards in food production. Hazard Analysis Critical Control Point system is considered as the best process management system by the National Advisory Committee for Microbiological Criteria for Foods, National Academy of

Science, and Codex Alimentarius Commission.

In 1996, the food borne outbreak caused by *Escherichia coli* O157:H7 in Japan and detection of that organism in imported beef in Korea heightened the public's awareness concerning food borne disease risks. Previously, chemical and pesticide residues were perceived as the greatest risk for humans. The *E. coli* outbreak and detection shifted the concern to microbial contaminants, particularly, *Escherichia coli* O157:H7; *Salmonella spp.*, *Campylobacter* and *Listeria monocytogenes*. This shift in awareness and opinion resulted in policy changes concerning food safety. Policy changes stated that food safety is a shared responsibility from the farm to the table, involving the producer, veterinarian and packer as well as the food service establishment and home preparation. Recognition of this shared responsibility has stimulated research on the application of prevention and control methodologies along the entire food chain. One such application is the Hazard Analysis and Critical Control Point (HACCP) system which identifies specific hazard(s) and preventive measures for their control. Previously, accepted as part of the food preparation industry, HACCP is now being adopted for use from animal production through slaughter worldwide. The HACCP system, as it applied to meat production, is considered to be a food safety management system using the approach of controlling critical points in food handling to prevent food safety problems. It is a system which can be used to assure food safety at all levels of food handling and is an important element in the overall management of food quality and safety more commonly referred to as Good Manufacturing Practices (GMP). The HACCP concept was developed in the late 1960s as a quality assurance system to enhance food safety. The basic principles underlying the concept were not new, but the introduction of HACCP signaled a shift in emphasis from resource intensive end-product inspection and testing to preventive control of hazards at all stages of food production. HACCP was initially developed by the food industry for use by food processors to prevent or control hazards, thereby improving

food safety. The application of the HACCP system has been evolving and expanding to form a basis for official food control and for establishing food safety standards for the international food trade as well. HACCP is considered to be one of the most effective and efficient ways to enhance food safety. A great deal of national and international activity related to the utilization of HACCP based systems in food safety assurance is currently under way. HACCP is increasingly being promoted throughout the world and, in some countries, food control agencies are mandating the food industry, including food importers and exporters, to use HACCP based systems to assure food safety. In an environment of economic restraint, governments are under constant pressure to limit spending and to look for more efficient and effective mechanisms to carry out their food control mandate.

History and philosophy of HACCP

HACCP, or the Hazard Analysis Critical Control Point system, is a common-sense, science-based approach to food production that is based on preventing hazards. In HACCP system, the priority is to control chemical, physical and microbiological hazards throughout the entire production process- from the farm to the table.

The basic of the HACCP were developed by Pillsbury Company with cooperation and participation of The National Aeronautics and Space Agency (NASA), the Natick Laboratories of the U.S. Army, and the U.S. Air Force Space Laboratory Project Group (Bauman, 1992). First used by the Pillsbury Company in the 1960s to produce the safest food possible for the astronauts in the space program. The HACCP system was first exposed to the public during the 1971 National Conference on Food Protection (U.S. Dept. HEW, 1972). Following this conference, Pillsbury was granted a contract by Food and Drug Administration (FDA) to conduct classes for FDA personnel on the HACCP system. The first comprehensive document on HACCP was published by Pillsbury Company (1973) and was used for training FDA inspectors in HACCP principles. A special

session was held with personnel involved in FDA's acidified and low-acid canned food regulation. This group developed the necessary information for the promulgation of the acidified and low-acid canned food regulation (FDA, 1973) which is a successful HACCP system. HACCP has been used in the plants of Pillsbury Company since 1971. During the 1970's and early 1980's a number of companies requested and were given information and help in establishing their own HACCP programs. It wasn't until 1985 that the HACCP system was seriously considered for broad application in the food industry. In 1985 the HACCP system was recommended by the National Academy of Science (NAS) in the publication "An Evaluation of the Role of Microbiological Criteria for Foods and Food Ingredients" (NAS, 1985). The NAS Committee (Subcommittee on Microbiological Criteria for Foods and Food Ingredients) concluded that a preventive system (HACCP) was essential for control of microbiological hazards. They concluded that end product testing was not adequate to prevent food borne diseases. In 1987, the National Oceanic and Atmospheric Administration (NOAA) was charged by congress "to design a program of certification and surveillance to improve the inspection of fish and seafood consistent with the hazard analysis critical control points system." This effort has been carried out by the National Marine Fisheries Service. They have also developed definitions of terminology used in HACCP. In the late 1980s, the federally-established National Advisory committee on Microbiological Criteria for Foods developed seven principles of HACCP, which have been adopted worldwide by the food industry. The principles define a HACCP system by identifying where hazards can occur, establishing acceptable limits for the hazards, and routinely monitoring and controlling the process. Verification and record keeping of the HACCP system validate that the system is working properly. The NAS committee has further refined HACCP by adding to the principles of HACCP appropriate descriptions of what each principle involves.

HACCP's foundation is science which is the best process control system available for the food industry. HACCP relies on identifying hazards by conducting risk assessments, adopting new technologies and processes that are proven to reduce pathogens, and devoting resources to the most critical areas for food safety. It has been endorsed by worldwide scientific agencies responsible for food safety. Improving the safety of meat products is the common goal of industry, government and consumers. Food safety is everyone's responsibility, from the farm to restaurants and consumer tables. Adopting HACCP throughout the entire food chain will ensure the highest level of safety.

Principles of HACCP

The development of a HACCP plan and a HACCP system involves the application of five preliminary steps and seven principles. These are:

Preliminary steps

1. Assemble the HACCP team.
2. Describe the food and the method of its distribution.
3. Identify the intended use and consumers of the food.
4. Develop a flow diagram which describes the process.

• Then apply the seven principles beginning with conducting a hazard analysis. The following steps should be considered when developing an effective HACCP system. Before developing the HACCP system it is important to ensure that an adequate sanitation system (sanitation standard operating procedures-SSOPs) is in place for compliance with FSIS regulation. Good Manufacturing Practice (GMPs) and SOPs are important because they establish basic operational parameters for the production of safe food. **Assembling the HACCP Team:** An important step in developing a plan is to gain management commitment and assemble a HACCP team. Top management must be fully committed to product safety through HACCP to make the Program effective. After commitment is obtained, the HACCP team should be assembled. The team should consist of individual(s) from all aspects of production and should include

at least one HACCP trained individual.

Product Description: The description should include the products within the process, their distribution, intended use, and potential consumers. This step will help ensure that all areas of concern are addressed. **Flow Diagram:** The HACCP team should develop and verify a flow diagram for production of the product(s). A simple flow diagram which includes every step of production is necessary. The flow diagram should be verified for accuracy and completeness by physically walking through each step in the diagram on the plant floor. The purpose of the flow diagram is to provide a clear, simple description of the steps in the process which are directly under the control of the facility.

Hazard Analysis

A hazard has been defined as any biological (B), chemical (C) or physical (P) property that may cause a food to be unsafe for human consumption. The hazard analysis is one of the most critical steps in the development of a HACCP plan. The HACCP team must conduct a hazard analysis and identify steps in the process where significant hazards can occur. The significant hazards must be “of such a nature that their prevention, elimination, reduction or control to acceptable levels is essential to the production of safe food.” (NACMCF, 1992). The team should focus on risk and severity as criteria for determining whether a hazard is significant or not. Risk, as defined by the National Advisory Committee is, “likelihood of occurrence.” “The estimate of risk is usually based on a combination of experience, epidemiological data, and information in the technical literature.” (NACMCF, 1992). Severity is the potential magnitude of the consequences to the consumer if the hazard is not adequately controlled. Hazards that are not significant or not likely to occur will not require further consideration in the HACCP plan. The hazard analysis and identification of associated preventive measures accomplishes the following: Identifies hazards of significance and associated preventive measures.

The analysis can be used to modify a process or product to further assure or improve food safety. The analysis provides a basis for determining CCPs, principle 2.

Critical Control Point (CCP)

A CCP is any point, step, or procedure at which control can be applied so that a food safety hazard can be prevented, eliminated, reduced, or controlled to acceptable levels. Information developed during the hazard analysis should enable the HACCP team to identify which steps in the process are CCPs. A decision tree, such as the NACMCF Decision Tree may be useful in determining if a particular step is a CCP for an identified hazard.

Different facilities preparing the same product can differ in the risk of hazards and the points, steps, or procedures which are considered CCPs. This can be due to differences in each facility layout, equipment, selection of ingredients, or the production process that is being used.

Critical Limit

A critical limit is a criterion that must be met for each preventive measure associated with a CCP. Therefore, there is a direct relationship between the CCP and its critical limits that serve as boundaries of safety. Critical limits may be derived from sources such as regulatory standards and guidelines, scientific literature, experimental studies, and advice from experts.

Critical limits must be based on the best information available at the time to provide a safe product and yet must be realistic and attainable. Establishments must keep in mind that any product which does not meet the critical limit must have a Corrective Action taken. Corrective actions may be as simple as re-processing or re-packaging or may require destroying the product.

Monitoring:

Monitoring is a planned sequence of observations or measurements to assess whether a CCP is under control and produces an accurate record for future use in verification.

Monitoring serves three purposes:

1. Monitoring is essential to food safety management in that it tracks the systems operation.
2. Monitoring is used to determine when there is a loss of control and a deviation occurs at a CCP, exceeding the critical limit. Corrective action must then be taken.
3. Monitoring provides written documentation for use in verifying the HACCP plan.

Because of the potential serious consequences of a critical defect, monitoring procedures must be effective. Continuous monitoring is possible with many types of equipment, and it should be used when possible.

Individuals monitoring CCPs must:

- 1) Be trained in the technique used to monitor each preventive measure;
- 2) Fully understand the purpose and importance of monitoring;
- 3) Have ready access to the monitoring activity;
- 4) Be unbiased in monitoring and reporting; and
- 5) Accurately report the monitoring activity.

All records associated with monitoring must be signed or initialed, dated, and the time recorded by the person conducting the monitoring activity.

Corrective Actions: Corrective actions are procedures to be followed when a deviation occurs. Because of variations in CCPs for different products and the diversity of possible deviations, specific corrective action plans must be developed for each CCP. The actions must demonstrate that the CCP has been brought under control and that the product is handled appropriately.

Record-Keeping

Record keeping is a critical aspect of the HACCP system. Records must be accurate and reflect the process, the deviations, the corrective actions, etc. Lack of accurate, current records may be cause for withholding or suspension of inspection from the plant. It is also important that all HACCP records dealing with CCPs and corrective actions taken, be reviewed on a daily basis

by an individual who did not produce the records and who has completed a course in HACCP, or the responsible establishment official who must sign or initial, date and record the time all records are reviewed. The HACCP plan and associated records must be file at the meat and/or poultry establishment.

Verification:

Verification consists of the use of methods, procedures or tests in addition to those used in monitoring to determine that the HACCP system is in compliance with the HACCP plan and whether the HACCP plan needs modification. There are three processes involved.

- 1) The scientific or technical process to verify that critical limits at CCPs are satisfactory review of critical limits to verify that the limits are adequate to control hazards that are likely to occur.
- 2) Process verification to ensure that the facility's HACCP plan is functioning effectively.
- 3) Documented periodic reassessment, independent of quality audits or other verification procedures, that must be performed to ensure the accuracy of the HACCP plan.

Sanitation SOPs: According to USDA's Pathogen Reduction/HACCP regulation (USDA,1996), effective establishment sanitation is essential for food safety and to successfully implement HACCP. There are direct and substantial links between inadequate sanitation and the contamination of meat and poultry products by pathogenic bacteria. Sanitation SOPs are necessary because they clearly define each establishments responsibility to consistently follow effective sanitation procedures and substantially minimize the risk of direct product contamination and adulteration.

Microbial testing for indicator organisms can be used to validate CCP effectiveness, and to establish in-plant trend analysis. Microbial testing should be part of a sanitation program in order to validate effectiveness. Microbial testing does not indicate that the product is safe, but it is used to verify that the process was in control.

Seven principles of HACCP: adopted by the National Advisory Committee on Microbiological Criteria of Foods (NACMCF, 1992)

1. Conduct a hazard analysis. Prepare a list of steps in the process where significant hazards occur and describe the preventive measures. Three types of hazards:

Biological - primarily concerned with pathogenic bacteria, such as *Salmonella*, *Staphylococcus aureus*, *Campylobacter jejuni*, *Clostridium perfringens*, *Clostridium botulinum*, *Listeria monocytogenes*, and *Escherichia coli* 0157:H7; also should consider *Trichinella spiralis*, and other parasites, as well as potential pathological concerns.

Chemical - toxic substances or compounds that may be unsafe for consumption; i.e., cleaners, sanitizers, pesticides, insecticides, rodenticides, paint, lubricants, etc.

Physical - foreign objects which may injure the consumer; i.e. rocks, stones, wood, metal, glass, nuts, bolts, screws, plastic, knife blades etc.

2. Identify the critical control points (CCPs) in the process. A critical control point is defined as a point, step or procedure at which control can be applied and a food safety hazard can be prevented, eliminated or reduced to an acceptable level.
3. Establish critical limits for preventive measures associated with each identified CCP. A critical limit is defined as a criterion that must be met for each preventive measure associated with a CCP. Each CCP will have one or more preventive measures that must be properly controlled to assure prevention, elimination, or reduction of hazards to acceptable levels. Each preventive measure has associated with it critical limits that serve as boundaries of safety for each CCP.
4. Establish CCP monitoring requirements. Establish procedures for using the results of monitoring to adjust the process and maintain control.
5. Establish corrective action to be taken when monitoring indicates that there is a deviation from an established critical limit.

6. Establish effective record-keeping procedures that document the HACCP system. Establish procedures for verification that the HACCP system is working correctly.

The written document that is developed from the application of these steps to the production of a food product is the HACCP Plan. The next step is to implement the plan with the result being a HACCP system. Finally HACCP system must be maintained through periodic verification and updating.

Importance of HACCP under World Trade Organization (WTO)

To address the role of Codex standards in the World Trade Organization (WTO) and what are now binding obligations on governments in that organization, it is important first to understand the two different WTO agreements under which the Codex standards are relevant. The agreement on Technical Barriers to Trade (TBT Agreement) was first negotiated in 1979 as part of the Tokyo Round of negotiations as a limited membership agreement under GATT. Currently the WTO has 112 member governments but it is expected to rise to at least 125 members, the number of governments in the GATT when the negotiation concluded.

The Technical Barriers to Trade Agreement and the Sanitary and Phytosanitary Agreement are two very distinct agreements, their references to Codex standards are different and they have different legal implications.

The Technical Barriers to Trade Agreement is defined according to the type of measure it covers and the Sanitary and Phytosanitary Agreement is defined according to the objective of a measure. The Technical Barriers to Trade Agreement covers all technical regulations (mandatory requirement), voluntary standards and conformity assessment procedures; any other kind of a measure is not covered by the TBT Agreement. On the other hand, the Sanitary and Phytosanitary Agreement covers any kinds of measure whose purpose is to protect human health from food-borne risks and animal carried diseases; to protect animal health from risks in feedstuffs and from animal diseases

and to protect plant health. Under the Sanitary and Phytosanitary Agreement it makes no difference what kind of measure is used, only its purpose. The distinction between these two agreements is important when considering the Codex standards because the legal obligations are very different under these two agreements. The SPS Agreement recognizes the right of governments to restrict trade in order to protect health and it has as an objective the improvement of health conditions. However, the SPS Agreement is an umbrella agreement. It does not go into the details of how governments must go about taking SPS measures, but provide the basic rules against which the measures will be judged in case of a trade dispute. As an umbrella agreement, it also allows for bilateral agreements in this area.

The SPS agreement recognizes the right of a government to restrict trade when it is necessary to protect health, but the decision as to whether a measure is necessary to protect health must be based on scientific principles. A government cannot restrict trade or maintain a restriction against available scientific evidence. One provision of importance for Codex is that the agreement encourages governments to use international standards, and in terms of food safety it very explicitly indicates the Codex standards. The recognized Codex standards are those relating to food additives, veterinary drug residues, pesticides, contaminants, methods of analysis and sampling, and codes and guidelines of hygienic practice. The SPS Agreement treats standards, guideline and recommendation the same.

Several paragraphs related to food safety are documented in the guideline prepared by Codex Committee on Food Import and Export Inspection and Certification System. Risk analysis should be applied to all parts of the food chain, including agricultural inputs and pre-harvest procedures, to enable inspection resources to be targeted effectively on hazards to public health. Within the Codex system, procedures have been established for the assessment of risks arising from the presence in food of additives, chemical contaminants, pesticide residues and veterinary drug residues. Biological agents such as bacteria,

viruses, parasites, etc., have not in the past been the subject of systematic risk assessment by the Codex Alimentarius Commission.

The principles of HACCP developed by the Codex Committee on Food Hygiene provide a systematic basis for the effective identification and prevention of hazards in food, including biological hazards. The use of a HACCP approach by food businesses should be recognized by governments as fundamental tool for improving the safety of foodstuffs.

The United States Department of Agriculture (USDA) published a final rule in July 1996 mandating that HACCP be implemented as the system of process control in all USDA inspected meat and poultry plants. As part of its effort to assist establishments in the preparation of plant-specific HACCP plans, Food Safety and Inspection Service (FSIS) determined that a generic model for each process defined in the regulation will be made available for use by the industry. In May 1996, FSIS awarded Contract Number 53-3A94-6-04 to the International Meat and Poultry HACCP Alliance for the development of ten generic HACCP models.

47.5.4 APEDA Role in promoting Exports

The Agricultural and Processed Food Products Development Authority (APEDA), under Government of India, Ministry of Commerce is engaged in promoting exports of meat and meat products by quality control. There is a significant increase in the meat exports every year.

There is an urgent need for the development of this model system on the traditional food products, processed fishery products as well as raw meats. Implementation of this system is beginning step but Indian food industry and government are focusing their endeavor to ensure food safety in India and increasing meat exports.

Now APEDA is also in the process of implementing HACCP system in India to boost the export of meat and meat products.

48. MARKETING OF PIGS AND PORK

48.1 Availability, Demand and Consumer Preference

48.1.1 Availability

The average per capita availability of pork in India based on total population works out to 210 gms per annum on the basis of persons having social objection to consume pork. This is almost negligible in comparison to the per capita availability of pork in Europe, America and other countries.

48.1.2 Demand for Pork Products

The effective demand for pork and pork products is increasing due to the diversification created by modern pork processing industrial technology. The consumption of these products has been related to psychological dimensions such as preference.

48.1.3 Consumer Preference

The consumer preference is based on visual attractiveness, taste, availability and nutritive composition. The consumer preference in metropolitan city like Mumbai, based on percentage of the actual sale of products over the total sale of all products indicated sausages to be most popular (50%) followed by fresh pork (30%), ham and bacon (15%) and canned pork products (5%) of total sale. The consumption of pork and pork products is comparatively restricted to small sections of the population. The poorest urban sections and the tribals consume fresh pork and a small sections of urban population consume pork and pork products.

48.2 Marketing of Pigs

48.2.1 Marketing of Piglets

There are more than 158 pig breeding farms in the Government sector, which are not adequate for meeting the requirement of piglets for establishment of new enterprises. There is an urgent need to establish new pig breeding farms in private sector for fulfilling the gap in demand and supply.

48.2.2 Marketing of Fattener Pigs

Pigs are purchased by the bacon factories and private processors. But at present they are offering remunerative price

to the farmers. The cost of pig production is very high as 80% is spent on feed. In North-Eastern Region, agents are offering very attractive price, the rate of live pigs/kg is about Rs. 80/.

48.3 Marketing of Fresh Pork

Fresh pork is being sold at butcher shop and in local market. The facilities for keeping under refrigerator are very limited and not available.

48.4 Marketing of Pork Products

Most of the pork is sold as fresh and about 10% is being converted into pork products. Directorate of Marketing and Inspection is giving license for processing of pork products under "Meat Food Products Order, 1973". The government bacon factories have adopted a price policy for sale of pork and pork products, which is linked with the purchase price of the pigs. The price of pork and pork products varies greatly in different parts of the country. The price of pork products is highest in North-Eastern region.

48.5 Future Market for Pork and Pork Products

The formation of adequate marketing facilities like collection, distribution, education and training would increase in the number of pig farms. There is a great potentiality for the diversification of production in the form of ham, bacon, sausages and canned pork. The pork and pork products can be marketed to hotels and restaurants, hostels and clubs, Airlines, Defence service canteen and mess and super-markets.

48.6 Marketing Constraints and Strategies

In the cycle of pig production marketing holds a vital place. The marketing of live pigs is still in infancy and a number of problems required to be solved. Some of the points requiring consideration are purchase policy, lack of processing facilities, arrangement for collection of pigs and their transport etc. Most of the farmers engaged in the pig production are from the weaker and poorer sections of the society and experience difficulty in transporting their live animals to the bacon factories. These problems can be solved by the establishment of recognized collection centre and small rural abattoir for pigs.

49. RECORD KEEPING AND REGISTRATION

Records plays an important role in pig farm management and pork production. Farm management has been done for centuries with simple data. In modern times, pig production became more intensified, more data is required to keep the business more profitable. Good pig management is based on good stockmanship, knowing targets and achievements and making comparisons between individual pigs and between pig farms.

49.1 Why Keep Records?

In the pig industry, information is a vital tool to the pig farmer. A small farmer with a few sows unit would never need any form of sophisticated information system, but on a larger scale, with more sows on his farm, the farmer need some sorts of information management system to keep tract of all pigs. Keeping pig records in memory is not enough. A pig farm owner must be able to supply the veterinarian with written records about the pigs at farm.

49.2 Methods of Record Keeping

One should keep records to tell when pigs were vaccinated, dipped, given any medicine or castrated. You must know how many pigs were treated, what was the problem and how often do some diseases occur at your farm. If you want to improve your pig farm, then you need to keep records of the boars and sows of every piglet. Individual records of every pig should be maintained based on following important parameters:

- Breeds of the pigs- Purebred or crossbred (%)

- Record of each boar- feeding, service

- Production performance of each boar

- Production performance of each sows

- Sow feeding schedule

- Age at first puberty

- Age at breeding

- Date of mating or AI

- Repeat mating or AI

- Diagnosis of Pregnancy and Confirmation

Date of Farrowing
Litter size (No. of piglets born at birth)
Litter weight (kg)
Date of weaning
Weaning weight
No. of piglets at weaning
Mortality (%) from birth to weaning
No. lost per litter
Weight per pig at weaning (kg)
Total litter weight at weaning
Feed lot period
Daily gain (kg)
Feed conversion efficiency
Feed and its formulation
Feed required from birth to Market weight
No. of days from birth to market
Disease control data
Date of swine fever vaccine
Re-vaccination date
Deworming
Sick pig record and treatment

49.3 Computers in Farm Record Keeping

A computer is an electronic device capable of receiving and storing data, performing prescribed numeric or logical operations on the data, and reporting the results of those operations. The computers have altered our life-styles and became essential to business including pig industry. Computers are the problem solver that offer the advantages of speed, accuracy, economy and reliability. The use of digital computers in the control of pork products processing operations has resulted into improved and more consistent standards of products quality and reductions in material wastage and energy expenditure.

A computer is a machine that stores and process data in such a way, the program directs to do. A computer consists of hardware and software. The hardware is the equipment, i.e. the

Disk Drive, Key Board, Visual Display Unit (VDU) or screen and an output device, printer. The software is the program which is stored on floppy or hard disk. Development within the computer world is very fast and there has been a technological revolution over the last few years. The computer keyboard, an input device looks like a typewriter keyboard: This keyboard is connected with Video Display screen. The display screen, which also functions as an output device, often called a monitor. The heart of the computer is its Central Processing Unit (CPU). The CPU has two major components. First, it has a control unit which can read and understand the program, second it contains a logic unit which interprets the results of the information entered through key board. Printer is another essential, item of a computer system. It gives a hard copy on the paper.

All computer use programs, called software. A good program which is basically a list of carefully worded instructions, which actually works on system. One can buy packaged programs designed to do many things. Special program for specific use can also be created and stored on disks to use over and over again. A farm computer is a relatively new technology it can be used in piggery farms, pork processing units and slaughter houses. The computer can only process data so that we can better decisions.

The computerization can improve the production capabilities of the piggery farms. It can help in management of reproductive performance of sows, feeding schedule, diagnosis and control of diseases. The computer plays an important role in helping to make marketing decisions. It can also provide critical information for the financial management of the pig farm business.

Modern data processing system and software can guide us through our records to analyze the cause of the problem and solution. A good program can tell us in advance that specific pigs will not touch the production standards, and thus helps in culling.

49.4 Sow Management by Computers

The miniature electronic devices are being implanted under the skin of the sow are used as secure indicators of sow's identity. If a transponder is implanted parallel to the sow's vagina, every birth of a piglets can be recorded. One could program a computer in such a way that an alarm is triggered as soon as the interval between 2 births is longer than, for instance, 45 minutes. The alarm could alert the pig farmer, through a paging device or by telephone, so that assistance could be given to that sow. From the computer he may also receive details of the intervals separating previous births and of the level of supervision needed for the at earlier farrowing.

Computerized systems and implants will help breeding management of sows, by checking automatically whether a sow is in oestrous and showing the most appropriate time for her mating or artificial insemination. They will also identify those sows or gilt in group housing which have failed to maintain their pregnancy.

The computer can also manage information on sows feeding, how often sow eats and how much time she spends in eating, also the normal time of day for her to take her feed. The data would form a part of behavioral profile for every pig.

49.5 Pig Herd Registration Scheme

In India, no pig herd registration scheme is functioning but there is an urgent need to introduce pig registration scheme at central level. This can be effectively done with the use of computer and data-management programme. This scheme would also be useful to monitor the production of better adopted exotic breeds of pigs and conservation of Indian pig breeds.

50. DIRECTORY

50.1 Animal Quarantine & Certification Station

Regional Officer, AQCS, Caltex Building,
Cargo Complex, Calcutta Airport,
Calcutta-700052

Quarantine Officer, AQCS, Delhi Gurgaon
Road, Kapashera, Delhi-110037

Quarantine Officer, AQCS, C/o Central
Poultry Breeding Farm, Aarey Milk
Colony, Mumbai-400065

Regional Officer, AQCS, Pallikarani Village,
Madras-601302

50.2 Advertisers of PIYB 2000

Advertisers	Page No.
Adsgo Trading Corporation	
& Thames Bend Farms	156
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IMM Limited & Blue Cross	
Consultants Ltd.	169
IMV India (P) Ltd.	483
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Pfizer Limited	331

50.3 Agricultural Universities/ Institutes

Assam Agricultural University, Jorhat-
785013

Bidhan Chandra Krishi Vishwa Vidyalaya, PO
Mohanpur-741252, Nadia (West Bengal)

Birsa Agricultural University, Kanke, Ranchi-
834006

Central Agricultural University, Irosemba,
Imphal-795001, Manipur

Central institute of Fisheries Education,
Jaiprakash Road, Seven Bungalow,
Mumbai-400061

Chandra Shekhar Azad University of Science
& Technology, Kanpur-208002

Chaudhary Charan Singh Agricultural
University, Hisar-125004 (Haryana)

Dr. Y. S. Parmar University of Horticulture
& Forestry, Nauni-173230 (District
Solon) Himachal Pradesh

Govind Ballabh Pant University of Science
& Technology, Pantnagar-263145

Gujarat Agricultural University, Sardar
Krishi Nagar, Banaskantha-385506

Himachal Pradesh Krishi Vishwa Vidyalaya,
Palampur-176002

Indian Agricultural Research Institute, Pusa,
New Delhi-110012

Indian Veterinary Research Institute,
Izatnagar-243122 (UP)

Indira Gandhi Krishi Vishwa Vidyalaya,
Raipur-492001

Jawahar Lal Nehru Krishi Vishwa Vidyalaya,
Jabalpur-482004

Kerala Agricultural University, Vellanikkara-
690654

Konkan Krishi Vidyapeeth, Dapoli-415712
(Maharashtra)

Mahatma Phule Krishi Vidyapeeth, Rahuri-
413722 (Maharashtra)

Marathwada Agricultural University,
Parbhani-4314001

Narendra Deva University of Agriculture &
Technology, Faizabad-224001

National Dairy Research Institute, Karnal-
132001 (Haryana)

Orissa University of Agriculture &
Technology, Bhubaneswar-751003

Punjab Agricultural University, Ludhiana-
141004

Punjabrao Krishi Vidyapeeth, Krishinagar,
Akola-444104

Rajasthan Agricultural University, Bikaner
(Rajasthan)

Rajendra Agricultural University, Veterinary
College Campus, Patna-800014

Sher-e-Kashmir University of Agricultural
Sciences & Technology, Raja Zaman's
Building, Dalgate, Srinagar (J&K)

Sher-e-Kashmir University of Agricultural
Sciences and Technology, 45-B,
Gandhinagar, Jammu Tawi-180001
(J&K)

Tamil Nadu Veterinary and Animal Sciences
University, Chennai-600007

Tamilnadu Agricultural University,
Coimbatore-641003

University of Agricultural Sciences,
Dharwad-580005 (Karnataka)

University of Agricultural Sciences, Hebbal,
Bangalore-560024

West Bengal University of Animal and Fishery Sciences, Belgachia, Calcutta (West Bengal)

50.4 Bacon Factories

Bacon Factory, Central Dairy Farm, Aligarh-202122

Government Bacon Factory, Gannavaram-521101, Andhra Pradesh

Government Bacon Factory, Harringhatta-721436, Mohanpur, Nadia, West Bengal

Government Bacon Factory, Kanke-834005, Rachi, Bihar

MAFCO Bacon Factory, National Park, Borivilli, Mumbai-400022

Meat Complex, Alwar-301001, Rajasthan

Meat Products of India, Koothatukulam-686662, Ernakulam, Kerala

Pork Processing Plant, Kharar-140301, Punjab

50.5 Banks

Allahabad Bank, HO 2, Netaji Subhash Road, Calcutta-700001

Andhra Bank, Central Office, Andhra Bank building, Sultan Bazar, Hyderabad-500001, ANDHRA PRADESH

Bank of Baroda, Central Office, 3, Walchand Hirachand Marg, Ballard Pier, Bombay-400038

Bank of India, Head Office, Express Towers, Nariman Point, Mumbai-400021

Bank of Maharashtra, Head Office, 1177 Budhwar Peth, Pune-411002

Bank of Rajasthan Limited, Bhagat Niwas, MI Road, Jaipur-302001

Canara Bank, 112, J.C. Road, PB No. 6648, Canara Bank Head Office, PW & I, Bangalore-560002

Central Bank of India, Head Office, Chandere Mukhi, Nariman Point, Mumbai-400021

Citizen Co-operative Bank Ltd. Central Administrative Office, Helena, 57, Mt. Carmel's Road, Bandra West, Mumbai-400050

Corporation Bank Head Office, Mangla Devi Temple Road, Mangalore-575001(DK)

Dena Bank, Head Office, 17, Horniman Circle, Fort, Mumbai-400023

Export Import Bank of India, Maker Chamber IV, 222, Nariman Point, Bombay-400021

Federal Bank Limited, Head Office, North Beach Road, Chennai-600001

Indian Bank, c/o Agricultural Finance Deptt., APEC, Indian Bank Head Office, 31, Rajaji Salai, Chennai, Tamilnadu

Indian Bank, Head Office, 31, Rajaji Salai, Chennai-600001

Indian Overseas Bank, Central Office, 762, Anna Salai, Chennai-600002

Karur Vysya Bank Limited, Central Office, Erode road, Karur-639002, Tamil nadu

Laxmi Commercial Bank, Head Office, "H" Block, Connaught Circus, New Delhi-110001

National Bank for Agriculture & Rural Development (NABARD), Poonam chambers, Dr. Annie Besant Road, Worli, Mumbai-400018

New Bank of India, Head Office, 1, Tolstoy Marg, New Delhi-110001

Oriental Bank of Commerce, Head Office, Priority Sector Department, 2nd Floor, Rachna Building, Rajendra Place, New Delhi-110008

Punjab National Bank, Head Office, Parliament Street, New Delhi-110001

Small Industries Development Bank of India, Head Office, Vikas Deep, 22, Station Road, Lucknow-226019, Uttar Pradesh

State Bank of Bikaner & Jaipur, Tilak Marg, C-Scheme, Jaipur-302005

State Bank of Hyderabad, Head Office, 5-9-187/1, Gunfoundry, Hyderabad-500001

State Bank of India, Central Office, New Administrative building, Madam Cama Road, Mumbai-400021

State Bank of Indore, Head Office, 5 Yeshwant Niwas Road, Indore-452003

State Bank of Mysore, Head Office, KG Road, Bangalore-560009

State Bank of Patiala, Head Office, The Mall, Patiala-147001

State Bank of Saurashtra, Darbargadh, Bhavnagar-364001, Gujarat

State Bank of Travancore, Head Office, Trivandrum-695012

Syndicate Bank, Head Office, Manipal-576119, Karnataka

Union Bank of India, Central Office, 239, Backbay Reclamation, Nariman Point, Mumbai-400021

Union Bank of India, Rural Development Officer, Adalhat, Distt. Mirzapur-231302

United Bank of India, Head Office, 16, Old Court House Street, Calcutta-700001

United Commercial Bank, Head Office, 10 Biplabi Trailokya Maharaj Sarani, Brabourne Road, Calcutta-700001

Vijaya Bank, Head Office, 28/1, Residency Road, Bangalore-566369

Vysya Bank Limited, Agricultural Finance Cell, No. 72, St. Mark's Road, Bangalore-560001

50.6 Bureau of Indian Standards

Bureau of Indian Standards, Food & Agriculture Division, Bahadur Shah Zafar Marg, NEW DELHI-110002.

50.7 Central Zoo Authority

Central Zoo Authority, Shahjahan Road, New Delhi-110001

50.8 Department of Food

Processing Industries

Meat & Meat Products Division, Department of Food Processing Industries, Ministry of Agriculture, Panchsheel Bhawan, Khelgaon Marg, New Delhi-110049

50.9 Directorate of Marketing & Inspection

Agricultural Marketing Adviser to the Govt. of India, Directorate of Marketing & Inspection, N.H. IV, Faridabad, HARYANA

Agricultural Marketing Adviser to the Govt. of India, Directorate of Marketing & Inspection, Room No. 573, Nirnan Bhavan, New Delhi-110001

Joint Agricultural Marketing Adviser, Directorate of Marketing & Inspection, Branch Head Office, New Sectt. Building, Nagpur-440001, MAHARASHTRA

Deputy Agricultural Marketing Adviser, Directorate of Marketing & Inspection, Incharge Northern Region, 4/20, Asaf Ali Road, New Delhi-110002

Deputy Agricultural Marketing Adviser, Directorate of Marketing & Inspection, Incharge Wewtern Region, III Floor, New C.G.O. Building, New Marine Lines, Mumbai, MAHARASHTRA

Deputy Agricultural Marketing Adviser, Directorate of Marketing & Inspection, General Pool Office Building, 4th Floor, A-wing, Bloc D.F., Sect. 1, Salt Lake, Calcutta, WEST BENGAL.

Deputy Agricultural Marketing Adviser, Directorate of Marketing & Inspection, Incharge Sourthern Region, Shastri Bhavan, 4th Floor, North Wing, C.G.O. Building, 35, Haddows Road, Chennai-600006, TAMIL NADU

Deputy Agricultural Marketing Adviser, Directorate of Marketing & Inspection, Tobacco Road, Kotapet, Guntur, ANDHRA PRADESH

Deputy Agricultural Marketing Adviser, Directorate of Marketing & Inspection, 3rd Floor, Lakhar Bhawan, Kali Ram chowdhari Marg, Gauhati-781009, ASSAM

Deputy Agricultural Marketing Adviser, Directorate of Marketing & Inspection, 135, Malvia Nagar, Flat No. 5, IInd Floor, Bhopal, MADHYA PRADESH

Deputy Agricultural Marketing Adviser, Directorate of Marketing & Inspection, I.P.S.T.A. Bhawan, 163, New Town, Cochin-58

Deputy Agricultural Marketing Adviser, Directorate of Marketing & Inspection, S.C.O. No. 92, 1st Floor, Sector 32-D, Chandigarh, PUNJAB

Officer Incharge, The Central Agmark Laboratory, North Amazari Road, Nagpur, MAHARASHTRA

50.10 Export Development

Authority

Agricultural & Processed Food Products Development Authority (APEDA), Institutional Area, Khelgaon Marg, NEW DELHI-110049.ex

50.11 Feed Analytical

Laboratories

Regional Feed Analytical Lab. C/o Central Poultry Breeding Farm, Aarey Milk Colony, Mumbai-400065.

Regional Feed Analytical Lab., C/o Central Poultry Breeding Farm, Industrial Area, CHANDIGARH-160002

Regional Feed Analytical Lab., C/o Central Poultry Complex, Nayapalli, Bhubaneswar-751012

50.12 Fodder Seed Production

Farm- Central

Central Fodder Seed Production Farm, Hessarghatta, Bangalore-560088, KARNATAKA

50.13 ICAR Institutes

ICAR Research Complex, ICAR Goa

ICAR North Eastern Council Research Complex, Shillong, Meghalaya

50.14 Insurance Companies

General Insurance Corporation of India, Industrial Assurance Building, Churchgate, Mumbai-400020.

National Insurance Company Ltd., Head Office, 3, Middleton Street, Calcutta-700071.

New India Assurance Co. Ltd., 87, Mahatma Gandhi Road, Fort, Mumbai-400023.

Oriental Insurance Co. Ltd., Oriental House, A-25/27, Asaf Ali Road, New Delhi-110002.

United India Insurance Co. Ltd., 24, Whites Road, PB No.6 76, Chennai-600014.

50.15 International Organizations

Animal Production and Health Commission for Asia and the Pacific (APHICA), FAO Regional Office for Asia and the Pacific, Maliwan Mansion, Phra Atit Road, Bangkok 10200 Thailand

Australian Centre for International Agricultural Research (ACIAR), GPO Box No 1571, Canberra, ACT 2601, Australia
CAB International, Wallingford, Oxon OX10 8DE, United Kingdom

Food and Agriculture Organization of the United Nations (FAO), Via delle Terme di Caracalla 00100 Rome, Italy

International Atomic Energy Agency (IAEA), c/o Joint FAO/IAEA Division of Nuclear and Biotechnology Applications in Food and Agriculture, A-1400 Vienna, Wagramerstrasse 5, Austria.

International Development Research Centre (IDRC), Regional Office for Asia, 11 Jor Bagh, New Delhi-110003.(Regional Director, Animal Production Systems)

International Development Research Centre (IRDC), Regional Officer, Animal Production Systems, 7th Story, RELC Building, 30 Orange Grove Road, Tanglin, PO Box No. 101, Singapore.

International Federation of Agricultural Producers (IFAP), 21, Rue Chaptal, F-75009 Paris, France.

International Fund for Agricultural Development (IFAD), 107 Via del Serafico, 00142 Rome, Italy.

International Laboratory for Research on Animal Diseases (ILRAD), PO Box No. 30709, Nairobi, Kenya.

International Livestock Centre for Africa (ILCA), PO Box No. 5689, Addis Ababa, Ethiopia.

International Species Information System (ISIS), 12101 Johnny Cake Ridge Road, Apple Valley, MN 55124, USA; Internet: <http://www.ISIS.org>

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- Japan Veterinary Medical Association, Shin Aoyama Building (West F23), 1-1-1, Minami Aoyama, Minato-ku, Tokyo, Japan 107
- National Institute of Science Communication (CSIR), Dr. K.S. Krishnan Marg, New Delhi-110012.is
- Natural Resources Institute, Central Avenue, Chatham maritime, Kent ME4 4TB, UK
- Office International des Epizooties (OIE), 12, Rue de Prony, 75017, Paris, France.
- Research Centre for Bioscience in Animal Production, Faculty of Veterinary Science, Chulalongkorn University, Henri Dunaant Street, Bangkok 10330, Thailand.
- World Association of Veterinary Pathologists, Ecole Veterinaire, F-94704, Alfort Cedex, France.
- World Bank, (India Office), Lodhi Estate, NEW DELHI-110001.in
- World Food Programme (WFP), Via Cristoforo Colombo 426, 00145 Rome, Italy.
- World Health Organization (WHO), Avenue Appia, 1211 Geneva 27, Switzerland.
- 50.16 Meat Food Products Order**
Meat Food Products Order, Directorate of Marketing & Inspection, NH-4, FARIDABAD, HARYANA
- 50.17 Meat & Livestock Corporations**
A. P. State Meat and Poultry Corporation Ltd, Shantinagar, Hyderabad-500028 ANDHRA PRADESH
Assam Livestock and Poultry Corporation Limited, Chenikuthi, Guwahati-781003 ASSAM
Delhi Livestock Products Processing Corporation Ltd, 5/9, Under Hill Road, Delhi-110054 DELHI
Goa Meat Complex Limited, Vishal Building, Dr. Braganza Pierera Road, St. Inez, Panaji-403001 (Goa) GOA
Jammu & Kashmir State Sheep & Sheep Products Development Board, Nowshera, Srinagar (J&K)JAMMU & KASHMIR
Karnataka Meat & Poultry Marketing Corporation Ltd., No. 7, Victoria Road, Bangalore-560047 KARNATAKA
Karnataka Sheep and Sheep Products Development Board, 21, Rashtreeya Vidyalaya Road, Bangalore-560080 KARNATAKA
Kerala Livestock Development Board, 9/1148, Mani Bhavan, Sasthamanglam, Trivandrum - 695010 (Thiruvananthapuram) KERALA
Meat Products of India Limited, Edayar, Koothattukulam-686662 (Distt. Ernakulam) Kerala KERALA
M. P. Rajya Pashudhan Evam Kukkut Vikas Nigam, main Road No. 3, Kotra Sultanabad, Bhopal-460002 MADHYA PRADESH
Maharashtra Sheep and Goat Development Corporation Ltd., Medhi Farm, Gokhale Nagar, Pune-411016 MAHARASHTRA
Punjab Agro Industries Development Corporation Ltd., 2A, Sector 28A, Madhya Marg, Chandigarh PUNJAB
Sikkim Livestock Processing Development Corporation, Krishi Bhavan, Tadong-737102, Gangtok (Sikkim) SIKKIM
Tamil Nadu Meat Corporation Ltd, TAPCO, Complex No. 2, Chamiers Road, Nandanam, Chennai-600035 TAMIL NADU
U. P. Pashudhan Udyog Nigam Limited, Central Dairy Farm, Aligarh-202122 UTTAR PRADESH
U. P. Poultry & Livestock Specialities, Badshah Bagh, Animal Husbandry Directorate, Lucknow-226001 UTTAR PRADESH
West Bengal Livestock Processing Development Corporation, 6A, Raja Subodh Mullick Square, 8th Floor, Calcutta-700013 WEST BENGAL

50.18 National Bureau of Animal Genetic Resources

National Bureau of Animal Genetic Resources, NDRI, Karnal, Haryana

50.19 National Institute of Communicable Diseases

National Institute of Communicable Diseases, 22, Sharnath Marg, Delhi

50.20 Pharmaceuticals

Alarsin, Pharmaceutical Division, Plot No. A-32, Road No.3, MIDC, Opp ESIS Hospital, Andheri (E), Mumbai-400093

Alembic Chemical Works Co. Ltd., Alembic Road, Baroda-390003

Alved Pharmaceuticals (P) Ltd., 5, Chandra Bagh Avenue, Dr. Radha krishnan Road, Chennai-600004

Cadila Healthcare Ltd., Aqrovet Division, Cadila, Khemka house, Drive-In, Ahmedabad-380052

Cyanamid India Ltd., Nyloc House, 254, D2, Dr. A.B. Road, Post Box No. 9109, Mumbai-400025

Dabur Ayurved Limited, 22, Site IV, Sahibabad, Ghaziabad-201010, UP

E Merck (India) Limited, Shivsagar Estate A, Dr. A.B. Road, Worli, PB No.16554, Mumbai-400018

Glindia Limited, Agrivet Farm Care Division, Dr. A.B. Road, Worli, Mumbai-400025

Herbs India Pvt. Ltd., 311, 1st Main, 40th Cross, 8th Block, Jayanagar, Bangalore-560082

Hindustan Ciba-Geigy Limited, Animal Health Division, 14-J.Tata Road, Mumbai-400020

Hoechst Roussel Vet Pvt. Ltd., Registered Office, Neeta Park, Building No. 1, Airport Road, Yerwada, Pune-411006p

Indian Herbs, Sherdanagar, PB No.5, Saharanpur-247001

Indian Herbs Research & Supply Co. Ltd, PB No. 5, Sharda Nagar, Saharanpur-247001,UP

Intervet (India) Pvt. Ltd., 412, Thakur Mansion Lane, Somajiguda, Hyderabad-500082

May & Baker (India) Ltd., May & Baker House, Worli, PB No.9150, Mumbai-400025

Merind Limited, New India Centre, 17-Cooperage Road, Mumbai-400039

Pfizer Limited, Technical Services (Veterinary), Patel Estate, Jogeswari West, Mumbai-400102

Rallis India Limited, Pharmaceutical & Chemicals Division, Ralli House, 21 DS Marg, PB No.166, Mumbai-400001

Ranbaxy Laboratories Limited, Devika Tower, 12th Floor, New Delhi-110019

Roche Products Limited, Vitamin Division, 28 Pt MM Malviya Road (Tardeo Road), PB No. 7901 Mumbai-400034

Sarabhai Chemicals, Marketing Head Office, Veterinary Division, Administration Building, 3rd Floor, Gorwa Road, Baroda-390007

Vetcare, Division of Tetragon Chemie Pvt. Ltd., Registered Office; IS 40, KHB Ind. Area, Yelahanka New Town, Bangalore-560064

Wockhardt Veterinary Pvt. Ltd., Poonam Chambers, Shivsagar Estate, Dr. A.B. Road, Mumbai-400018

50.21 Pig/ Animal/ Veterinary Journals

Andhra Pradesh Veterinarian, AP Veterinary Council, Shantinagar, Hyderabad-500028. ANDHRA PRADESH

Asian Livestock, APHCA Secretariat, FAO Regional Office for Asia and Far East, Maliwan Mansion, Phra Atit Road, Bangkok 2, THAILAND

CLFMA News Letter, The Compound Livestock Feed Manufacturers Association of India, 111, Mittal Chamber, 11th Floor, 228, Nariman Point, Mumbai 400021

- Feed Trends, The Compound Livestock Feed Manufacturers Association of India, 111, Mittal Chamber, 11th Floor, 228, Nariman Point, Mumbai 400021
- Indian Journal of Animal Sciences, ICAR Krishi Anusandhan Bhawan, PUSA, New Delhi-110012
- The Indian Veterinary Journal, 7, Chamiers Road, Chennai-600035, TAMIL NADU
- International Pig Tropics, PO Box. 4, Driffield, East Yorkshire, YO25 9DJ, England
- Livestock Adviser, 97, St. John's Church Road, Bangalore 560005, KARNATAKA
- Pashudhan, 311, 1st Main, 40th Cross, 8th Block, Jayanagar, Bangalore-560082
- Pig International, 18, Chapel Street, Petersfield, Hampshire GU32 3DZ, ENGLAND
- The Veterinarian, 123, 7th B Main Road, IV Block (West) Jayanagar, Bangalore-560011, KARNATAKA
- World Animal Review, FAO, Via delle Terme di caracalla, 00100 Rome, ITALY
- 50.22 Pig Breeding Farms**
- 50.22.1 AICRP on Pigs/ PD on Pigs**
- All India Co-ordinated Research Project on Pigs, Indian Veterinary Research Institute, Izatnagar-243122, UTTAR PRADESH
- Project Directorate on Pigs, Guwahati, ASSAM
- All India Co-ordinated Research Project on Pigs, Khanapara-781022, Guwahati, ASSAM
- All India Coordinated Project on Pigs, Veterinary College Compound, Tirupati-517502 ANDHRA PRADESH
- AICRP Centre, Kanke, Birsa Agricultural University, Ranchi, BIHAR
- AICRP Centre, ICAR Research Complex, Goa, GOA
- All India Coordinated Research Project on Pigs, Kattupakkam, Livestock Research Station, Kattupakkam, KERALA
- All India Coordinated Research Project on Pigs, Kerala Agricultural University, Mannuthy, KERALA
- All India Co-ordinated Research Project on Pigs, Adhartal, J.N.K.V.V., Jabalpur-482004 MADHYA PRADESH
- All India Coordinated Research Project on Pigs, Tamil Nadu Veterinary and Animal Sciences University, Chennai, TAMIL NADU
- Note- At presesnt Project Co-ordinator, All India Co-ordinated Project on pigs is at IVRI, Izatnagar, which would be converted into Project Directorate on Pigs, with HQ at Guwahati, Assam. The two new centres at Goa and Ranchi has been proposed to open soon.*
- 50.22.2 Government Pig Farms**
- Government Pig Breeding Farm, Herminder Bay, Little Andaman, ANDAMAN & NICOBAR
- Model Piggery Farm, Gannavaram-521102 (Distt. Krishna) ANDHRA PRADESH
- Pig Breeding Station, Gopannapalem-534450 (Distt. West Godawari) ANDHRA PRADESH
- Pig Breeding Farm, Muktalaya-521184 (Distt. Krishna) ANDHRA PRADESH
- Pig Breeding Station, Padavagi (Distt. West Godawari) ANDHRA PRADESH
- Government Pig Farm, Vishakhapatnam-530001 ANDHRA PRADESH
- Government Pig Breeding Farm, Vizianagaram, ANDHRA PRADESH
- Government Pig Farm, Along, PO Along, District West Siang, ARUNACHAL PRADESH
- Government Pig Farm, Baliza, Roing, PO Roing, Dibang Valley Distt. ARUNACHAL PRADESH
- Government Pig Breeding Farm, Daporijo, ARUNACHAL PRADESH
- Government Pig Farm, Karsingsa-79110, Post Nirjuli, Itanagar, ARUNACHAL PRADESH
- Regional Exotic Pig Breeding Farm, Loiliang, Teju-792001 (Lohit Distt.) ARUNACHAL PRADESH

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- Government Pig Breeding Farm, Seppa,
ARUNACHAL PRADESH
- Government Pig Farm, Tawang, Tawang
District ARUNACHAL PRADESH
- Government Pig Breeding Farm, Ziro,
ARUNACHAL PRADESH
- Government Pig Farm, Diphu, Anglong-
782460 (Distt. Karbi) ASSAM
- Government Pig Breeding Farm, Dirpai,
ASSAM
- Government Pig Breeding Farm,
Dongkamokana, ASSAM
- Government Pig Breeding Farm, Gongaon,
ASSAM
- Government Pig Breeding Farm, Haflong,
ASSAM
- Government Pig Farm, Kaliapani, ASSAM
- Government Pig Breeding Farm, Kaphahtoli,
ASSAM
- Government Pig Farm, Khanapara-781022
Guwahati, ASSAM
- Government Pig Farm, Khanikar, PO Sessa
(Distt. Dibrugarh) ASSAM
- Government Pig Breeding Farm, Kokrajhar,
ASSAM
- Government Pig Breeding Farm,
Koockuhuwa, ASSAM
- Government Pig Farm, Marigoan-782105
ASSAM
- Government Pig Farm, Gaurikarma (Distt.
Hazaribagh) BIHAR
- Government Piggery Farm, Gopahari, PO
Tatanagar-831002 Jamshedpur, BIHAR
- Government Piggery Farm, Hotwar (Distt.
Ranchi) BIHAR
- Government Pig Farm, Kanke, Ranchi-
834006 BIHAR
- Pig Breeding cum Demonstration Farm, Port
Silvassa-396230 DADRA & NAGAR
HAVELI
- Government Piggery Farm, Curti Ponda,
GOA
- Government Pig Breeding Farm, Ambala
City-134003 HARYANA
- Government Pig Breeding Farm, Hisar-
125004, HARYANA
- Government Pig Breeding Farm, Bangarpet,
Kolar District, KARNATAKA
- Government Pig Farm, Hessarghatta,
BANGALORE KARNATAKA
- Government Pig Farm, Koila-574288
KARNATAKA
- Government Pig Farm, Kudige-571232
KARNATAKA
- Pig Breeding Unit, Angamaly-683572 (Distt.
Ernakulam) KERALA
- Pig Breeding Farm, Kappad-686554,
Kanjirappally, KERALA
- Government Pig Breeding Farm, Kappadu,
Kanjirapally, Kottayam District, KERALA
- Government Pig Breeding Farm,
Kodappankunnu, Thiruvananthapuram,
KERALA
- Government Pig Breeding Farm, Kolony,
Thodupuzha, PO Idukki District, KERALA
- Pig Breeding Unit, Kunnamkulam, Distt.
Thrissur, KERALA
- Government Pig Breeding Farm, Kuriottumla,
Elikkattoor, PO Punalur, Kollam District,
KERALA
- Government Pig Farm, Mundayad-670597.
Kannur District, KERALA
- Government Pig Breeding Farm, Parasala-
695502, Thiruvananthapuram District,
KERALA
- Pig Breeding Unit, Thalayolaparambu,
Kottayam District, KERALA
- Government Pig Breeding Farm, Bastar-
494223 MADHYA PRADESH
- Government Pig Breeding Farm, Sakalo
(Distt. Ambikapur) MADHYA PRADESH
- Government Pig Breeding Farm, Saraswahi,
Jabalpur, MADHYA PRADESH
- Piggery Unit, Composite Livestock Farm,
None-795141 (Distt. Tamenglong)
MANIPUR
- Government Pig Breeding Farm, Dugailong,
Tamenglong, MANIPUR
- Government Pig Breeding Farm, Muirei
Village, Ukhrul District, MANIPUR
- Pig Breeding Farm, Tarang (IOKPI) PO
Moirang-795133 Bishendpur, MANIPUR

- Government Pig Breeding Farm, Tarungpopki, Bishanpur District, MANIPUR
- Government Pig Breeding Farm, Torbung-795128 (Distt. Churachandpur) MANIPUR
- Government Pig Breeding Farm, Uchanpopki, Chandel District, MANIPUR
- Government Pig Farm, Baghmara-794102 (Distt. West Garo Hills) MEGHALAYA
- Government Pig Breeding Farm, Dalu (West Garo Hills) MEGHALAYA
- Government Pig Farm, Jowai, Thadlaskein (Tamtia Hills) MEGHALAYA
- Government Pig Breeding Farm, Kongjeng (Distt. East Garo Hills) MEGHALAYA
- Government Pig Farm, Kyrdemkulai MEGHALAYA
- Government Pig Breeding Farm, Mawryngkneg (Distt. East Khasi Hills) MEGHALAYA
- Government Pig Breeding Farm, Moirang-793120 (Distt. West Khasi Hills) MEGHALAYA
- Government Pig Farm, Nongstoin-793119 Mairang (Distt. West Garo Hills) MEGHALAYA
- Government Pig Farm, Pynursla-793110, Shillong (Distt. East Khasi Hills) MEGHALAYA
- Government Pig Farm, Rongjeng-794110 (Distt. East Garo Hills) MEGHALAYA
- Government Pig Farm, Rongkhon, Tura (Distt. West Garo Hills) MEGHALAYA
- Government Pig Breeding Farm, Champhai MIZORAM
- Government Pig Breeding Farm, Hnathial MIZORAM
- Piggery Demonstration Farm, Kolasib-796081 MIZORAM
- Government Pig Breeding Farm, Lungpher-Lungloi-796701 MIZORAM
- Pig Processing Farm, Mainpuri, MIZORAM
- Government Pig Breeding Farm, Phaileng, West Phaileng, MIZORAM
- Regional Pig Breeding Farm, Selesih, MIZORAM
- Government Pig Breeding Farm, Tanhril, Thingdawl, MIZORAM
- Piggery Demonstration Farm, Thenzwal MIZORAM
- Government Pig Farm, Alukute (Distt. Zunhelio) NAGALAND
- Government Pig Breeding Farm, Jalukie, NAGALAND
- Regional Exotic Pig Breeding Farm, Medziphema (Distt. Dimapur) NAGALAND
- Pig Breeding Centre, Merang (Distt. Kong) NAGALAND
- Government Pig Breeding Farm, Merangkong, Mokochung, NAGALAND
- Government Pig Breeding Farm, Phek-797108 NAGALAND
- Government Pig Farm, Suthazu, PO Chazonlea, NAGALAND
- Government Pig Farm, Tizit (Distt. Mon) NAGALAND
- Pig Breeding Centre, Tuensang-798612 NAGALAND
- Government Pig Farm, Wokha-797111 (Distt. Wokha) NAGALAND
- Government Pig Breeding Farm, Bhanjanagar-761126 ORISSA
- Government Pig Breeding Farm, Bhanjagarh ORISSA
- Government Pig Farm, Chiplima-76802 PO Kalamati, ORISSA
- Government Pig Breeding Farm, Kuanrawunda ORISSA
- Government Pig Breeding Farm, Malkangiri, ORISSA
- Pig Breeding Farm, Matkambada-758036 (Distt. Keonjar), ORISSA
- Government Pig Breeding Farm, Randapalli, ORISSA
- Government Pig Breeding Farm, Kariamamickam-605106, PONDICHERRY
- Government Pig Breeding Farm, Badal (Distt. Faridkot) PUNJAB
- Government Pig Breeding Farm, Chhajju Majra, Kharar (Distt. Ropar) PUNJAB
- Government Pig Breeding Farm, Gurdaspur-143521 PUNJAB

- Government Pig Breeding Farm, Jalandhar-144021 PUNJAB
- Pig Breeding Farm, Punjab Agricultural University, Ludhiana-140004 PUNJAB
- Government Pig Farm, Malwal (Distt. Ferozpur) PUNJAB
- Government Pig Farm, Mattewara (Distt. Ludhiana) PUNJAB
- Government Pig Breeding Farm, Nabha-147201 (Distt. Patiala) PUNJAB
- Government Pig Breeding Farm, Ajmer, Government Poultry Farm Complex, Ajmer RAJASTHAN
- Government Pig Breeding Farm, Alwar-301001 RAJASTHAN
- Government Pig Breeding Farm, Bharatpur-321001 RAJASTHAN
- Government Pig Breeding Farm, Chungthang, Bob, North Sikkim, SIKKIM
- Government Piggery Farm, Gyalsing-737111 (West Sikkim) SIKKIM
- Government Pig Breeding Farm, Karfektar, Jorethang, South Sikkim, SIKKIM
- Government Pig Breeding Farm, Mangalbary, West Sikkim, SIKKIM
- Government Pig Breeding Farm, Ralong, North Sikkim, SIKKIM
- Pig Breeding Unit, Tadong Livestock Farm, Tadong, Gangtok-737102 SIKKIM
- Government Pig Breeding Farm, Abhisliekapatti at Thirunelveli, TAMIL NADU
- Pig Breeding Unit, District Livestock Farm, Chettinad-623102 TAMIL NADU
- Government Pig Breeding Farm, Chinnasalem, Post V. Koot Road, (Via O Talavasa, Chinnasalem-636125 TAMIL NADU
- Pig Breeding Unit, District Livestock Farm, Hosur-635110 (Distt. Dharmapuri) TAMIL NADU
- Government Pig Breeding Farm, Mukuntharayapuram, Ranipet, TAMIL NADU
- Government Pig Breeding Farm, Orathanad-614525 (Tanjore), Orathanad Taluk, TAMIL NADU
- District Piggery Unit, Pudukottai-622001 TAMIL NADU
- Government Pig Farm, Saidapet, Veterinary Hospital Comprund, Chennai-600035 TAMIL NADU
- Pig Breeding Unit, District Livestock Farm, Udagamandalam-643001 TAMIL NADU
- Government Piggery Farm, Amarapur-799101 (Distt. South Tripura) TRIPURA
- Government Pig Breeding Farm, Debipur, TRIPURA
- Government Pig Breeding Farm, Dewanpasa, PO Huplengcherra, Tripura North, TRIPURA
- Pig Multiplication Farm, Gandhigram (Distt. Tripura West) TRIPURA
- Government Pig Breeding Farm, Howaribari, TRIPURA
- Composite Livestock Farm, Manaiathar, Belonia, Birchandramanu (South Tripura) TRIPURA
- Piggery Unit, Mendhihaor, Salema, Kamalpur (Distt. North Tripura) TRIPURA
- Naincherra Piggery Unit, Naincherra, Panisagar Distt. North Tripura, TRIPURA
- Regional Pig Breeding Farm, Nalkata, PO Kanchancherra (Distt. North Tripura) TRIPURA
- Government Pig Farm, Central Dairy Farm, Aligarh-202122 UTTAR PRADESH
- Government Pig Breeding Farm, Arazilines (Distt. Varanasi) UTTAR PRADESH
- Government Pig Farm, Barabanki-225002 UTTAR PRADESH
- Government Pig Farm, Basti-272001 UTTAR PRADESH
- Government Pig Farm, Dehradun-248003 UTTAR PRADESH
- State Piggery Farm, Kashipur-263001, Nainital-263001 UTTAR PRADESH
- Government Pig Farm, Lalitpur-284403 UTTAR PRADESH
- Government Pig Farm, Moradabad-244001 UTTAR PRADESH
- Government Pig Farm, Neelgaon-246453 UTTAR PRADESH

Government Pig Breeding Farm, Niblet
UTTAR PRADESH

Pig Breeding Farm, GB Pant Ag. University
Pantnagar -263145 Udham Singh Nagar
UTTAR PRADESH

Government Pig Breeding Farm, Pashulok,
Rishikesh, UTTAR PRADESH

Government Pig Breeding Farm, Bijanbari,
Darjeeling, WEST BENGAL

Government Pig Breeding Farm, Bijanbari,
Darjeeling, WEST BENGAL

Regional Pig Breeding Farm, Haringhatta-
712701 Mohanpur (Distt. Nadia) WEST
BENGAL

Government Pig Breeding Farm, Orgram,
WEST BENGAL

Government Pig Farm, Pedong-734311
(Darjeeling) WEST BENGAL

Government Pig Breeding Farm, Ramsai,
WEST BENGAL

Government Pig Breeding Farm, Salboni,
Midanapore, WEST BENGAL

Pig Breeding Farm, St. Mary's Hill-734220,
Tuski (Distt. Darjeeling) WEST BENGAL

Government Pig Farm, Suingruntaum, PO
Suigrunium (Distt. Darjeeling) WEST
BENGAL

50.22.3 ICAR Pig Farms

ICAR Piggery Farm, Ela (Old Goa), GOA

50.22.4 Krishi Vigyan Kendra Farms

Pig Breeding Farm, Krishi Vigyan Kendra,
Shri Bhagwat Bhakti Ashram, Rampura,
Rewari-123401, HARYANA

Pig Breeding Farm, Krishi Vigyan Kendra,
Village Tepla, PO Saha, Distt. Ambala-
133104, HARYANA

Pig Breeding Farm, Krishi Vigyan Kendra,
Majhgawan, Satna, MADHYA PRADESH

Pig Breeding Farm, Krishi Vigyan Kendra,
Chirantan Bungalow Sharma Safalya
Foundation, Madhuban Colony Camp,
Amravati-444602, MAHARASHTRA

Pig Breeding Farm, Krishi Vigyan Kendra,
Kard Tal., Risod, Distt Washim-444506
MAHARASHTRA

Pig Breeding Farm, Krishi Vigyan Kendra, PO
Chebri-799207, Distt. West Tripura,
TRIPURA

Pig Breeding Farm, Krishi Vigyan Kendra,
Allahabad, Allahabad Agricultural
Institute, Allahabad-211007, UTTAR
PRADESH

Pig Breeding Farm, Krishi Vigyan Kendra,
Ganiwan, Banda-210206, UTTAR
PRADESH

Pig Breeding Farm, Krishi Vigyan Kendra,
Gopalgram, PO Durgonwa, Gonda-
271125, UTTAR PRADESH

Pig Breeding Farm, Krishi Vigyan Kendra,
Sonamukhi, West Bengal
Comprehensive Area Development
Corporation, Sonamukhi-722087, Distt.
Bankura, WEST BENGAL

50.22.4 Livestock Corporation Farms

Pig Breeding Farm, Meat Products of India
Ltd., Edayar, Koothattukulam-686662
(Distt. Ernakulam) KERALA

Pig Breeding Farm, KLDB, Ayyampillikunni
in Puthoor Village, Thrissur District,
KERALA

50.22.5 University Pig Farms

50.22.5.1 Agri. University Farms

Pig Breeding Farm, Tirupati, Veterinary
College, APAU, Tirupati, ANDHRA
PRADESH

Pig Breeding Farm, Assam Agricultural
University Khanapara-781022
Guwahati, ASSAM

Pig Breeding Farm, Ranchi Veterinary
College, Birsa Agricultural University
Kanke, Ranchi-834006 BIHAR

Piggery Farm, Haryana Agricultural
University Hisar-125004 HARYANA

Pig Farm, Veterinary College, Hebbal,
Bangalore-562113 KARNATAKA

Pig Breeding Farm, Kerala Agricultural
University, Kodappanakunnu, KERALA

Pig Breeding Farm, Mannuthy-680651
Kerala Agri. University, KERALA

Pig Breeding Farm, Kerala Agricultural
University, Pilicode KERALA

Pig Breeding Farm, College of Veterinary Science & AH, Anjora, DURG, Indira Gandhi Krishi Vishwa Vidyalaya, DURG, MADHYA PRADESH

Pig Breeding Farm, Department of Veterinary Obstetrics & Gynaecology, Veterinary College, JNKVV, Civil Lines, Jabalpur-482001, MADHYA PRADESH

Pig Breeding Farm, Department of Animal Science, College of Agriculture, Central Agricultural University, Imphal, IMPHAL-795001 MANIPUR

50.22.5.2 Animal Science/

Veterinary University Farms

Pig Breeding Farm, Tamilnadu Veterinary and Animal Sciences University, Chennai, TAMIL NADU

Pig Breeding Farm, Mohanpur, West Bengal University of Animal Sciences, Mohanpur-712701, WEST BENGAL

50.23 Piggery Development

50.23.1 Government- Central

Assistant Commissioner, Piggery Unit, Government of India, Ministry of Agriculture, Department of Animal Husbandry & Dairying, R. No. 406, BWing, Shastri Bhawan, New Delhi-110001(India)

50.23.2 Government -State

Piggery Development Officer, Directorate of Animal Husbandry, Andaman & Nicobar Administration, Port Blair-744101

Piggery Development Officer, Directorate of Animal Husbandry, Andhra Pradesh, Shanti Nagar, Hyderabad-500004

Piggery Development Officer, Directorate of Animal Husbandry, Arunachal Pradesh, Nirjuli-791110 (Itanagar)

Piggery Development Officer, Directorate of Animal Husbandry, Assam, Guwahati-781003

Piggery Development Officer, Directorate of Animal Husbandry, Bihar, Patna-800015

Piggery Development Officer, Directorate of Animal Husbandry, Chandigarh Administration, Sector-22, Chandigarh-160022

Piggery Development Officer, Directorate of Animal Husbandry, Chandigarh Administration, Sector-22, Chandigarh-160022

Piggery Development Officer, Directorate of Animal Husbandry, Dadra & Nagar Haveli Administration, Silvassa-396230

Piggery Development Officer, Directorate of Animal Husbandry, Delhi State, Old Secretariat, Delhi-110054

Piggery Development Officer, Directorate of Animal Husbandry, Goa, Panaji-403001

Piggery Development Officer, Directorate of Animal Husbandry, Gujarat, Krishi Bhavan, Paldi, Ahmedabad-380006

Piggery Development Officer, Directorate of Animal Husbandry, Haryana, Sector 19-C, No.80-81, Chandigarh

Piggery Development Officer, Directorate of Animal Husbandry, Himachal Pradesh, Shimla-170002

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Piggery Development Officer, Directorate of Animal Husbandry, Jammu & Kashmir (Srinagar Region), Srinagar-190001

Piggery Development Officer, Directorate of Animal Husbandry, Karnataka, Vidhana Veethi, Bangalore-560001

Piggery Development Officer, Directorate of Animal Husbandry, Kerala, Vikas Bhavan, Trivandrum-695033

Piggery Development Officer, Directorate of Animal Husbandry, Lakshadweep Administration, Kavaratti-673555

Piggery Development Officer, Directorate of Animal Husbandry, Madhya Pradesh, Tulsinagar, Bhopal-462005

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Piggery Development Officer, Directorate of Animal Husbandry, Manipur, Imphal-795001

Piggery Development Officer, Directorate of Animal Husbandry, Meghalaya, Civil Secretariat (Add. Bldg), Shillong-793001

Piggery Development Officer, Directorate of Animal Husbandry, Mizoram, Aizwal-796001

Piggery Development Officer, Directorate of Animal Husbandry, Nagaland, Kohima-797001

Piggery Development Officer, Directorate of Animal Husbandry, Orissa, Cuttack-753001

Piggery Development Officer, Directorate of Animal Husbandry, Pondicherry, Pondicherry-605001

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Piggery Development Officer, Directorate of Animal Husbandry, Rajasthan, Krishi Bhavan, Jaipur-302001

Piggery Development Officer, Directorate of Animal Husbandry, Sikkim, Lower Sectt., Gangtok-737101

Piggery Development Officer, Directorate of Animal Husbandry, Tamilnadu, Central Office Building, Chennai-600006

Piggery Development Officer, Directorate of Animal Husbandry, Tripura, Agartala-799001

Piggery Development Officer, Directorate of Animal Husbandry, Uttar Pradesh, Badshah Bagh, Lucknow-226007

Piggery Development Officer, Directorate of Animal Husbandry, West Bengal, New Secretariat Building, 1, Kiran Sankar Ray Road, Calcutta

Piggery Development Officer, Directorate of Animal Husbandry, West Bengal, Writer's Building, Calcutta-700001

50.24 Planning Commission

Deputy Adviser (Animal Husbandry)
Planning Commission, Yojana Bhawan,
New Delhi-110001

50.25 Pork Products Research

Institutes

Meat & Meat Products Division, Central Food Technological Research Institute, Mysore-570013, Karnataka

National Research Centre on Meat, Indian Veterinary Research Institute, Izatnagar-243122, Uttar Pradesh

50.26 Veterinary Colleges

College of Veterinary Science, Rajendranagar, Hyderabad-500030.
ANDHRA PRADESH

College of Veterinary Science, Gannavaram.
ANDHRA PRADESH

College of Veterinary Science, Tirupati-517502, ANDHRA PRADESH

College of Veterinary Science, Khanapara, Guwahati-781022. ASSAM

College of Veterinary Science,, Lakhmipur-787001. ASSAM

Faculty of Veterinary Science & Animal Husbandry, Rajendra Agricultural University, Pusa, Samastipur-848125
BIHAR

Bihar Veterinary College, Patna-800014.
BIHAR

Faculty of Veterinary Science & Animal Husbandry, Birsa Agricultural University, Kanke, Ranchi-834007. BIHAR

College of Veterinary Science, Gujarat Agricultural University, Anand Campus, Anand-388001. GUJARAT

College of Veterinary Science & Animal Husbandry, Dantiwada Campus, Gujarat Agricultural University, Sardar Krushinagar-385506. GUJARAT

College of Animal Sciences, Haryana Agricultural University, Hissar-125004.
HARYANA

College of Veterinary Science, CSS, Haryana Agricultural University, Hisar-125004.
HARYANA

College of Veterinary Science, Himachal Pradesh Krishi Vishwavidyalaya, Palampur-176062, Distt. Kangra,
HIMACHAL PRADESH

- Faculty of Veterinary Science & Animal Husbandry (SKVAST), Shuhama (Alusteng), GPO Srinagar-190011. JAMMU & KASHMIR
- Veterinary College, Hebbal, Bangalore-560024. KARNATAKA
- College of Veterinary Science, Bidar-585401, KARNATAKA
- College of Veterinary & Animal Science, Mannuthy-680651. KERALA
- College of Veterinary Science & Animal Husbandry, Jabalpur-482001. MADHYA PRADESH
- College of Veterinary Science & Animal Husbandry, Mhow-453441. MADHYA PRADESH
- College of Veterinary Science, Anjora, Durg (Madhya Pradesh). MADHYA PRADESH
- College of Veterinary & Animal Science, Udgir-440006, MAHARASHTRA
- College of Veterinary & Animal Sciences, Parbhani-431401. MAHARASHTRA
- Bombay Veterinary College, Parel, Mumbai-400012. MAHARASHTRA
- K.N.P. College of Veterinary Science, Post-Shirwal-412801, Tal- Khandala, District Satara), MAHARASHTRA
- Faculty of Veterinary Science, Post Graduate Institute, Punjabrao Krishi Vidyapeeth (PKV), Akola-444204. MAHARASHTRA
- Nagpur Veterinary College, Seminary Hills, Nagpur-440006. MAHARASHTRA
- College of Veterinary Sciences & Animal Husbandry, Selesih, Ramhlum North, HD-28, Aizwal-796001. MIZORAM
- Faculty of Veterinary Science & Animal Husbandry, Orissa University of Agriculture and Technology, Bhubaneswar-751003. ORISSA
- Rajeev Gandhi College of Veterinary & Animal Sciences, Kurumbapet, PONDICHERRY-605009. PONDICHERRY
- College of Veterinary Science, Ludhiana-141004. PUNJAB
- College of Veterinary Science, Rajasthan Agricultural University, Bijay Dhawan, Bikaner-334001. RAJASTHAN
- Madras Veterinary College, Vepery, Chennai-600007. TAMIL NADU
- Faculty of Veterinary & Animal Science, Acharya Narendra Dev Agricultural University, Faizabad-224229, UTTAR PRADESH
- College of Veterinary Sciences, Pantnagar-263145. UTTAR PRADESH
- College of Veterinary Science & Animal Science, Mathura-281002. UTTAR PRADESH
- Faculty of Veterinary & Animal Science, West Bengal University of Animal & Fishery Science, 37 & 68, Kshudiram Bose Sarani, Belgachia, Calcutta-700037 WEST BENGAL
- 50.27 Veterinary Council of India**
Veterinary Council of India
16/15, WEA Karol Bagh, New Delhi-110005
- 50.28 Veterinary Research Institutes**
Indian Veterinary Research Institute, Izatnagar-243122. UTTAR PRADESH
Madras Veterinary College and Research Institute, Namakkal-637002, TAMIL NADU
- 50.29 Wildlife Institutes- Indian**
Wildlife Institute of India, Dehradun, Uttar Pradesh
- 50.30 Zoological Survey of India**
Zoological Survey of India, Prani Vigyan Bhawan, "M" Block, New Alipore, Calcutta-700053 (West Bengal)
- 50.31 Zoos with Wild Boar**
50.31.1 Zoos with Babirusa
Antwerp, Royal Zoological Society of Antwerp, W. de Meurichy, Belgium
Bandung Zoo, Indonesia
Berlin Zoo, (Zoologischer Garten), Federal Republic of Germany
Copenhagen Zoo, (Zoologisk have), Denmark
Frankfurt Zoo, Federal Republic of Germany

- Nuremberg Zoo, Federal Republic of Germany
- Poznan Zoo, Poland
- Rotterdam Zoo, (Stichting Koninklijke rotterdamse Diergaarde), The Netherlands
- Stuttgart Zoo, Federal Republic of Germany
- 50.31.2 Zoos with Babirusa and Pigmy Hog**
- Jakarta Zoo, (Kebun Binatang Ragunan), Indonesia
- Surabaya Zoo, (Kebun Binatang Surabaya), Indonesia
- 50.31.3 Zoos with Bearded Pig**
- Manila Zoo, Philippines
- Singapore Zoo, Singapore
- 50.31.4 Zoos with Wild Boar**
- Assam State Zoo, Gauhati, India
- Zurich Zoo, Switzerland
- Amte's Animal Park & Orphanage Cum Rescue home, Gadchiroli, Allapalli, Maharashtra, India
- Arinagar Anna Zoological Park, Vandalur, Tamil Nadu, India
- Bondla Zoo, Usgao, Goa, India
- Indira Gandhi Zoological Park, Visakhapatnam, Andhra Pradesh, India
- Jaipur Zoo, Jaipur, Rajasthan, India
- Kamla Nehru Zoological Garden, Ahmedabad, Gujarat, India
- Kota Zoo, Kota, Rajasthan, India
- Mahendra Chaudhary Zoological Park, Chhatbir, Punjab, India
- Maitri Bagh Zoo, Bhilai, Madhya Pradesh, India
- Manipur Zoological Garden, Imphal, Manipur, India
- Mini Zoo, Haddo, Port Blair, Andaman & Nicobar Islands, India
- Motijharan Deer Park, Sambalpur, Orissa, India
- Nandankanan Biological Park, Bhubaneswar, Orissa, India
- National Zoological Park, New Delhi, India
- Nehru Zoological Park, Hyderabad, Andhra Pradesh, India
- Safari Park, Haridasji-Ki-Magri, Udaipur, Rajasthan, India
- Sri Chamarajendra Zoological Gardens, Mysore, Karnataka, India
- State Museum and Zoo, Thrissur, Kerala, India
- Tata Steel Zoological Park, Jamshedpur, Bihar, India
- Thiruvananthapuram Zoo, Thiruvananthapuram, Kerala, India
- Udaipur Zoo, Udaipur, Rajasthan, India
- Van Vihar National Park, Bhopal, Madhya Pradesh, India
- Veermata Jijabai Bhosale Udyan & Zoo, Mumbai, Maharashtra, India

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